PATENT ABSTRACTS OF JAPAN

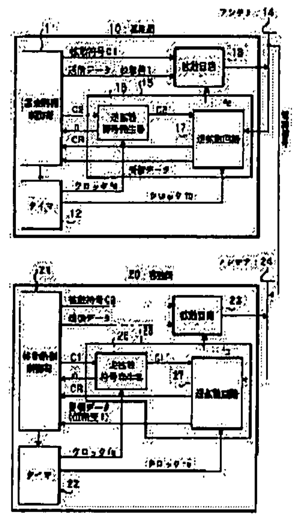
(11)Publication number : 11-252631
(43)Date of publication of application : 17.09.1999

(51)Int.Cl. H04Q 7/34
G01S 11/02

(21)Application number : 10-073186
(22)Date of filing : 05.03.1998

(71)Applicant : MATSUSHITA ELECTRIC IND CO LTD
(72)Inventor : HAYAKAWA TADASHI

(54) METHOD AND DEVICE FOR DETECTING DISTANCE



(57)Abstract:
PROBLEM TO BE SOLVED: To enable communication stations to transmit and receive a signal by each own timer in an asynchronous manner to a receiving timing and to facilitate distance detection without giving a large effect upon the communication of other information by performing distance detection according to phase difference including reference timing deviation and propagation delay time between the communication stations.
SOLUTION: A base station side controlling part 11 of a base station 10 is provided with a phase difference detection function and also an operation function for relative distance measurement from a mobile station 20 in addition to communication control that is a primary base station function in order for the mobile station that becomes a self-station to detect the relative distance from the base station by performing CDMA radio communication with the base station that becomes the opposite station. On the other hand, a mobile station side controlling part 21 of the station 20 is also provided with a phase difference detection function and an operation function to detect a relative distance from the station 10 in addition to communication control that is a primary mobile station function. It is possible to calculate a distance between the both stations from a prescribed expression based on phase differences, etc., which are detected by the stations 10 and 20.

LEGAL STATUS

[Date of request for examination]	05.01.2001
[Date of sending the examiner's decision of rejection]	
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	3436879

[Date of registration]	06.06.2003
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

* NOTICES *

CLAIMS

[Claim(s)]
[Claim 1] The distance detection approach that the Communication Bureau B which received the sending signal of the Communication Bureau A receives the signal generated and transmitted based on the criteria timing generated in the interior, detects the phase contrast of said sending signal and input signal, and detects the distance between the Communication Bureau A and the Communication Bureau B while transmitting the signal which has periodicity based on the criteria timing generated with the timer which the Communication Bureau A has to the Communication Bureau B.
[Claim 2] The distance detection approach of detecting the relative distance of a local station and a distant office using the phase contrast of the sending signal which received the signal which generates the signal of periodicity with the timer of said distant office, and is transmitted to a local station from the distant office concerned while the timer of a local station generates the signal of periodicity and transmitting to a distant office, and transmitted to the distant office from the local station, and the input signal which received from the distant office.
[Claim 3] The signal of the periodicity generated with the timer of a distant office is the distance detection approach according to claim 2 characterized by having the same period as the sending signal of a local station.
[Claim 4] The distant-office detection phase contrast which detected the amount of gaps of the receiving timing and the criteria timing of the timer of a distant office which received the sending signal from a local station by the distant office as phase contrast in a distant office. The distance detection approach according to claim 2 or 3 characterized by using for relative-distance detection the local station detection phase contrast which detected the amount of gaps of the receiving timing and the criteria timing of the timer of a local station which received the sending signal from a distant office by the local station as phase contrast in a local station.
[Claim 5] It is the distance detection approach according to claim 4 characterized by restoring to the input signal which received from the distant office, acquiring distant-office detection phase contrast, and degree type and relative-distance =Kx (distant-office detection phase contrast + local station detection phase contrast)/2, however :K detecting the relative distance of a local station and a distant office based on the constant equivalent to the velocity of light using said distant-office detection phase contrast and the local station detection phase contrast detected by the local station.
[Claim 6] The distance detection approach according to claim 4 characterized by restoring to the input signal which received from the distant office, acquiring distant-office detection phase contrast, and detecting the gap with the criteria timing of the timer of a local station, and the criteria timing of the timer of a distant office using said distant-office detection phase contrast and the local station detection phase contrast detected by the local station.
[Claim 7] It is the distance detection approach according to claim 6 characterized by a degree type, relative-distance =Kx local station detection phase contrast, however :K detecting the relative distance of a local station and a distant office based on the constant equivalent to the velocity of light after doubling the conventional time of the timer of a local station, and the timer of a distant office based on a gap of the detected criteria timing.

[Claim 8] After detecting a gap of the criteria timing of the distant office on the basis of the timer of a local station, a gap of the criteria timing of a distant office is considered as a distant-office timer gap, and it is the relative distance of a local station and a distant office Degree type and relative-distance =Kx (local station detection phase contrast-distant-office timer gap) however, : -- the distance detection approach according to claim 6 characterized by detecting K based on the constant equivalent to the velocity of light.
[Claim 9] The distance detection approach according to claim 1 to 8 characterized by the radio between a local station and a distant office being a spread-spectrum communication link.
[Claim 10] The distance detection approach according to claim 9 characterized by to search for local-station detection phase contrast based on the count of a shift which was made to shift relatively the back-diffusion-of-electrons sign which synchronized with the criteria timing of the timer of a local station to the input signal which carried out the diffusion modulation synchronizing with the criteria timing of the timer of a distant office, detected the correlation value of said input signal and said diffusion sign, and showed the greatest correlation value, and the shift amount per time.
[Claim 11] The distance detection approach according to claim 10 characterized by searching for local station detection phase contrast by choosing the correlation value beyond a predetermined value and performing an approximation calculation to the autocorrelation function of a diffusion sign using said selection correlation value.
[Claim 12] The distance detection approach according to claim 1 to 11 which chooses the reception pass which spread the minimum distance between a local station and a distant office, and is characterized by performing distance detection using the selected input signal of reception pass from Naka of two or more detected reception pass.
[Claim 13] The distance detection approach according to claim 12 characterized by choosing the reception pass of the earliest timing from Naka of two or more detected reception pass, and performing distance detection.
[Claim 14] The distance detection approach according to claim 12 characterized by choosing the high reception pass of receiving level from Naka of two or more detected reception pass most, and performing distance detection.
[Claim 15] The distance detection approach according to claim 1 to 8 characterized by the radio between a local station and a distant office being the radio of a TDMA method.
[Claim 16] The distance detection approach according to claim 15 characterized by detecting the gap with the slot reception anticipation timing from the distant office expected on the basis of the slot transmit timing assigned to the local station, and the slot receiving timing which received from the distant office actually as local station detection phase contrast.
[Claim 17] The location specification approach of pinpointing the location of the Communication Bureau where a location has not become clear based on the relative-distance information which detected the relative distance between the Communication Bureau where a location has not become clear, and two or more Communication Bureau where the location has become clear, respectively, and detected it using the distance detection approach according to claim 1 to 16.
[Claim 18] The location specification approach of pinpointing the location of a local station based on the relative-distance information which detected the relative distance between two or more distant offices the local station a location is not proved it being, and the location are proved they being, respectively, and detected it using the distance detection approach according to claim 1 to 16.
[Claim 19] The location specification approach of pinpointing the location of a distant office based on the relative-distance information which detected the relative distance between the local stations the distant office a location is not proved it being, and the location are proved they being, respectively, and detected it using the distance detection approach according to claim 1 to 16.
[Claim 20] The relative-speed-detector approach of shifting time amount, carrying out multiple-times measurement of the relative distance of a local station and a distant office using the distance detection approach according to claim 1 to 16, and detecting the relative velocity of a local station and a distant office from the variation of the relative distance per unit time amount.

[Claim 21] The correspondence procedure which exchanges other information at the same time it performs distance detection by the distance detection approach according to claim 1 to 16 among two or more Communication Bureau.
[Claim 22] The transmitting PAWA control approach characterized by performing transmitting PAWA control based on the distance information detected by the distance detection approach according to claim 9 to 16 among two or more Communication Bureau.
[Claim 23] While the timer of a local station generates the signal of periodicity and transmitting to a distant office, the signal which generates the signal of periodicity with the timer of said distant office, and is transmitted to a local station from the distant office concerned is received. The distant-office detection phase contrast which shows the amount of gaps of the receiving timing of the sending signal from a local station and the criteria timing of the timer of a distant office which were detected by the distant office is acquired from said input signal. The timer gap detection approach characterized by detecting the local station detection phase contrast which shows the amount of gaps of the sending signal which transmitted to the distant office from the local station, and the input signal which received from the distant office, and detecting a gap of the timer of a local station and a distant office based on said local station detection phase contrast and said distant-office detection phase contrast.
[Claim 24] The timer gap detection approach according to claim 23 characterized by asking for a gap of the timer of a distant office based on a degree type, and distant-office timer gap = (local station detection phase contrast-distant-office detection phase contrast) / 2 on the basis of the timer of a local station.
[Claim 25] The timer gap detection approach according to claim 23 characterized by asking for a gap of the timer of a local station based on a degree type, and local station timer gap = (distant-office detection phase contrast-local station detection phase contrast) / 2 on the basis of the timer of a distant office.
[Claim 26] The timer gap detection approach according to claim 23 to 25 characterized by the radio between a local station and a distant office being a spread-spectrum communication link.
[Claim 27] The timer gap detection approach according to claim 23 to 25 characterized by the radio between a local station and a distant office being the radio of a TDMA method.
[Claim 28] Distance detection equipment possessing a distance detection means detect the relative distance of a local station and a distant office using a transmitting means to generate the signal of periodicity with the timer of a local station, and to transmit to a distant office, a receiving means receive the signal which generates the signal of periodicity with the timer of said distant office, and is transmitted to a local station from the distant office concerned, and the phase contrast of the sending signal which transmitted to the distant office from the local station, and the input signal which received from the distant office.
[Claim 29] The signal of the periodicity generated with the timer of a distant office is distance detection equipment according to claim 28 characterized by having the same period as the sending signal of a local station.
[Claim 30] A distance detection means is distance detection equipment according to claim 28 or 29 which has a distant-office phase-contrast detection means restore the distant-office detection phase contrast which shows the amount of gaps of a local-station phase-contrast detection means detect the amount of gaps of the receiving timing and the criteria timing of the timer of a local station which received the sending signal from a distant office as local-station detection phase contrast, the receiving timing detected by the distant office from the input signal which received from the distant office, and the criteria timing of the timer of a distant office.
[Claim 31] Distance detection equipment [equipped with a timer gap detection means to detect the gap with the criteria timing of the timer of a local station, and the criteria timing of the timer of a distant office using distant-office detection phase contrast and local station detection phase contrast] according to claim 30.
[Claim 32] Distance detection equipment [equipped with a means to double the conventional time of the timer of a local station, and the timer of a distant office based on the timer gap

detected with the timer gap detection means] according to claim 31.
[Claim 33] It is distance detection equipment according to claim 32 characterized by a degree type, relative-distance =Kx local station detection phase contrast, however :K calculating the relative distance of a local station and a distant office based on the constant equivalent to the velocity of light after a distance detection means doubles the conventional time of the timer of a local station, and the timer of a distant office based on a gap of the criteria timing which the timer gap detection means detected.
[Claim 34] Distance detection equipment according to claim 28 to 33 characterized by the radio between a local station and a distant office being the radio of a spectrum diffusion method or a TDMA method.
[Claim 35] The mobile equipped with distance detection equipment according to claim 28 to 33.
[Claim 36] The fixed station equipped with distance detection equipment according to claim 28 to 33.
[Claim 37] Location recognition equipment which detects the relative distance between the Communication Bureau where a location has not become clear, and two or more Communication Bureau where the location has become clear using distance detection equipment according to claim 28 to 33, and pinpoints the location of the Communication Bureau where a location has not become clear based on the detected relative-distance information.
[Claim 38] Location recognition equipment which detects the relative distance between two or more distant offices the local station a location is not proved that it is, and the location are proved that they are using distance detection equipment according to claim 28 to 33, and pinpoints the location of a local station based on the detected relative-distance information.
[Claim 39] Location recognition equipment which detects the relative distance between the local stations the distant office a location is not proved that it is, and the location are proved that they are using distance detection equipment according to claim 28 to 33, and pinpoints the location of a distant office based on the detected relative-distance information.
[Claim 40] While receiving the absolute positional information of two or more base stations to the base station used as a distant office, a relative distance with a base station is detected from the input signal, and a circumference base station is location recognition equipment of a local station according to claim 37 to 39 which pinpoints a location absolutely from a location and the relative distance to the base station absolutely.
[Claim 41] Relative-speed-detector equipment which shifts time amount, carries out multiple-times measurement of the relative distance of a local station and a distant office using distance detection equipment according to claim 28 to 34, and detects the relative velocity of a local station and a distant office from the variation of the relative distance per unit time amount.
[Claim 42] Location recognition equipment according to claim 37 or 40 or mounted equipment equipped with relative-speed-detector equipment according to claim 41.
[Claim 43] Traffic information generation equipment which detects the relative distance or relative velocity of a local station and a distant office using distance detection equipment according to claim 28 to 34 or relative-speed-detector equipment according to claim 41, and generates traffic information using a detection result.
[Claim 44] Timer gap detection equipment equipped with a timer gap detection means detect the timer gap with a local station and a distant office using a transmitting means generates the signal of periodicity with the timer of a local station, and transmit to a distant office, a receiving means receive the signal which generates the signal of periodicity with the timer of said distant office, and is transmitted to a local station from the distant office concerned, and the phase contrast of the sending signal which transmitted to the distant office from the local station, and the input signal which received from the distant office.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the distance detection approach especially applicable to the mobile communication system of a spread-spectrum communication mode, and its equipment about the suitable distance detection [to detect the relative distance between mobile stations or between a mobile station and a base station] approach, and its equipment.
[0002]
[Description of the Prior Art] Recently, the ranging system which detects the relative distance of two mobiles using a spread-spectrum communication mode is developed. for example, the transmission wave in which certain Communication Bureau (self-vehicle) MS-11 carried out the diffusion modulation in the communication device between cars given in JP,5-122120,A other Communication Bureau (other vehicles) MS-2 — wireless transmission — carrying out — Communication Bureau MS-2 besides the above — the account of a top — the transmission wave which carried out the diffusion modulation with the diffusion sign which synchronized with the diffusion sign when the transmission wave by which the diffusion modulation was carried out from certain Communication Bureau MS-1 was received — the account of a top — it returns to certain Communication Bureau MS-11. When other response waves from Communication Bureau MS-2 are received, certain Communication Bureau MS-1 detected time difference after transmitting a transmission wave from Communication Bureau MS-1 until it receives a response wave from other Communication Bureau MS-2, and it has detected the relative distance between [of two] the Communication Bureau by the formula (1).
[0003]
Relative distance = velocity-of-light x time difference / 2 — (1)
[0004]
[Problem(s) to be Solved by the Invention] In the communication device between cars mentioned above, if a receiving station receives the transmission wave from a sending station, it is premised on the head of a diffusion sign carrying out the diffusion modulation of the response wave returned to a sending station with the diffusion (it having synchronized) sign which was mostly in agreement with receiving timing, and transmitting. For this reason, since it is forced to make the receiving station to which a response wave is returned generate a diffusion sign synchronizing with a received wave, and to return a response wave to it, it is difficult to carry various data in the communication device which communicates by the CDMA method in addition to range measurement.
[0005] Moreover, since distance detection is performed on the assumption that the response wave diffused with the diffusion sign to which the receiving station synchronized with the received wave in the sending station is returned, the synchronous precision of a receiving station will have direct effect on distance detection precision.
[0006] This invention is made in view of the above actual condition, and a sending station and a receiving station are asynchronous with the diffusion sign which makes it generate with the timer of a local station respectively, and as a signal can be transmitted and received, while being able to communicate other information to coincidence, it aims at offering the distance detection

approach which enabled distance detection with the high dependability which is not influenced, and its equipment for the synchronous precision of a receiving station.
[0007]
[Means for Solving the Problem] This invention provided the following means, in order to solve the above-mentioned technical problem.
[0008] While invention of the distance detection approach according to claim 1 transmits the signal which has periodicity based on the criteria timing generated with the timer which the Communication Bureau A has to the Communication Bureau B The Communication Bureau B which received the sending signal of the Communication Bureau A receives the signal generated and transmitted based on the criteria timing generated in the interior, detects the phase contrast of said sending signal and input signal, and detected the distance between the Communication Bureau A and the Communication Bureau B.
[0009] High detection precision can be realized without being able to carry out distance detection easily that the Communication Bureau of receiving timing is respectively asynchronous at its own timer, and should transmit [just] and receive a signal since phase contrast including a gap and the propagation-delay time of the criteria timing of the Communication Bureau and the Communication Bureau performs distance detection, without having big effect on the communication link of other information, and receiving effect in synchronous precision by this configuration, at a distant office.
[0010] While invention of the distance detection approach according to claim 2 generated the signal of periodicity with the timer of a local station and transmitted to the distant office, it receives the signal which generates the signal of periodicity with the timer of said distant office, and is transmitted to a local station from the distant office concerned, and detected the relative distance of a local station and a distant office using the phase contrast of the sending signal which transmitted to the distant office from the local station, and the input signal which received from the distant office.
[0011] Moreover, invention of distance detection equipment according to claim 28 A transmitting means to generate the signal of periodicity with the timer of a local station, and to transmit to a distant office, A receiving means to receive the signal which generates the signal of periodicity with the timer of said distant office, and is transmitted to a local station from the distant office concerned, The configuration possessing a distance detection means to detect the relative distance of a local station and a distant office using the phase contrast of the sending signal which transmitted to the distant office, and the input signal which received from the distant office from a local station is taken.
[0012] High detection precision can be realized without being able to carry out distance detection easily that a local station and the distant office of receiving timing are respectively asynchronous at their own timer, and should transmit [just] and receive a signal since phase contrast (local station detection phase contrast) including a gap and the propagation-delay time of the criteria timing of a local station and a distant office performs distance detection, without having big effect on the communication link of other information, and receiving effect in synchronous precision by these configurations, at a distant office.
[0013] Invention according to claim 3 made the signal of the periodicity which a distant office generates the signal of the same period as a sending signal in the distance detection approach of claim 2.
[0014] Moreover, invention according to claim 29 made the signal of the periodicity which a distant office generates the signal of the same period as a sending signal in distance detection equipment according to claim 28.
[0015] By this configuration, distance detection is attained by the radio by the spectrum spread system and the TDMA method which transmit and receive the signal of the periodicity of the same period as an input signal.
[0016] The distant-office detection phase contrast to which invention according to claim 4 detected the amount of gaps of the receiving timing and the criteria timing of the timer of a distant office which received the sending signal from a local station by the distant office as phase contrast in a distant office in the distance detection approach according to claim 2. The

local station detection phase contrast which detected the amount of gaps of the receiving timing and the criteria timing of the timer of a local station which received the sending signal from a distant office by the local station as phase contrast in a local station is used for relative-distance detection.
[0017] Moreover, invention according to claim 30 is set to distance detection equipment according to claim 28. A local station phase contrast detection means by which a distance detection means detects the amount of gaps of the receiving timing and the criteria timing of the timer of a local station which received the sending signal from a distant office as local station detection phase contrast, The configuration which has a distant-office phase contrast detection means to restore the distant-office detection phase contrast which shows the amount of gaps of the receiving timing and the criteria timing of the timer of a distant office which were detected by the distant office from the input signal which received from the distant office is taken.
[0018] Since distance detection can be carried out by these configurations using the phase contrast detected by the distant office, and the phase contrast detected by the local station, a local station and the distant office of receiving timing are respectively asynchronous at their own timer, and can transmit and receive a signal.
[0019] Invention according to claim 5 restores to the input signal which received from the distant office in the distance detection approach according to claim 4, and acquires distant-office detection phase contrast. The configuration which detects based on the constant by which degree type and relative-distance =Kx (distant-office detection phase contrast + local station detection phase contrast)/2, however :K are equivalent to the velocity of light in the relative distance of a local station and a distant office is taken using said distant-office detection phase contrast and the local station detection phase contrast detected by the local station.
[0020] Since distance detection can be carried out by this configuration using the phase contrast detected by the distant office, and the phase contrast detected by the local station, a local station and the distant office of receiving timing are respectively asynchronous at their own timer, and can transmit and receive a signal.
[0021] In the distance detection approach according to claim 4, invention according to claim 6 restores to the input signal which received from the distant office, acquires distant-office detection phase contrast, and detects the gap with the criteria timing of the timer of a local station, and the criteria timing of the timer of a distant office using said distant-office detection phase contrast and the local station detection phase contrast detected by the local station.
[0022] Moreover, invention according to claim 31 takes a configuration equipped with a timer gap detection means to detect the gap with the criteria timing of the timer of a local station, and the criteria timing of the timer of a distant office using distant-office detection phase contrast and local station detection phase contrast, in distance detection equipment according to claim 30.
[0023] By this configuration, since the gap with the criteria timing of the timer of a local station and the criteria timing of the timer of a distant office is detectable using distant-office detection phase contrast and local station detection phase contrast, a timer gap of a local station and a distant office can be amended easily.
[0024] After invention according to claim 7 doubles the conventional time of the timer of a local station, and the timer of a distant office in the distance detection approach according to claim 6 based on a gap of the detected criteria timing, a degree type, relative-distance =Kx local station detection phase contrast, however :K detect the relative distance of a local station and a distant office based on the constant equivalent to the velocity of light.
[0025] Moreover, after, as for invention according to claim 33, a distance detection means doubles the conventional time of the timer of a local station, and the timer of a distant office in distance detection equipment according to claim 31 based on a gap of the criteria timing which the timer gap detection means detected, the configuration which calculates the relative distance of a local station and a distant office based on the constant by which a degree type, relative-distance =Kx local station detection phase contrast, however :K are equivalent to the velocity of light is taken.

[0026] By this configuration, after doubling the conventional time of the timer of a local station, and the timer of a distant office, distance detection can be carried out only by detecting local station detection phase contrast, and improvement in the speed of distance detection can be attained.
[0027] In the distance detection approach according to claim 6, invention according to claim 8 considers a gap of the criteria timing of a distant office as a distant-office timer gap, after detecting a gap of the criteria timing of the distant office on the basis of the timer of a local station, and it is the relative distance of a local station and a distant office Degree type and relative-distance =Kx (local station detection phase contrast-distant-office timer gap) however, : -- K is detected based on the constant equivalent to the velocity of light.
[0028] By this configuration, after detecting a gap of the criteria timing of a distant office, distance detection can be carried out only by detecting local station detection phase contrast, and improvement in the speed of distance detection can be attained.
[0029] In the distance detection approach according to claim 1 to 8, the radio between a local station and a distant office of invention according to claim 9 is a spread-spectrum communication link.
[0030] Moreover, in distance detection equipment according to claim 28 to 33, the radio between a local station and a distant office of invention according to claim 34 is the radio of spectrum spread system or a TDMA method.
[0031] The distance detection which used the above-mentioned phase contrast by this configuration is realizable on spectrum spread system or a TDMA method.
[0032] Invention according to claim 10 shifts relatively the back-diffusion-of-electrons sign which synchronized with the criteria timing of the timer of a local station to the input signal which carried out the diffusion modulation synchronizing with the criteria timing of the timer of a distant office, detects the correlation value of said input signal and said diffusion sign, and searches for local-station detection phase contrast in the distance detection approach according to claim 9 based on the count of a shift which showed the greatest correlation value, and the shift amount per time.
[0033] By this configuration, when performing a spread-spectrum communication link, slide correlator etc. can be used and local station detection phase contrast can be searched for easily.
[0034] Invention according to claim 11 chooses the correlation value beyond a predetermined value in the distance detection approach according to claim 10, and local station detection phase contrast is searched for by performing an approximation calculation to the autocorrelation function of a diffusion sign using said selection correlation value.
[0035] By this configuration, local station detection phase contrast with a high precision can be searched for by performing an approximation calculation to the autocorrelation function of a diffusion sign.
[0036] In the distance detection approach according to claim 1 to 11, out of two or more detected reception pass, invention according to claim 12 chooses the reception pass which spread the minimum distance between a local station and a distant office, and performs distance detection using the selected input signal of reception pass.
[0037] Since the input signal of the reception pass which spread the minimum distance is used for distance detection by this configuration, exact distance detection is attained.
[0038] In the distance detection approach according to claim 12, invention according to claim 13 chooses the reception pass of the earliest timing out of two or more detected reception pass, and performs distance detection.
[0039] Since the input signal of the reception pass which spread the minimum distance is received to the earliest timing by this configuration, the input signal of the reception pass which spread the minimum distance can be chosen.
[0040] In the distance detection approach according to claim 12, invention according to claim 14 chooses the high reception pass of receiving level most from two or more detected reception pass, and performs distance detection.
[0041] Since the receiving level of the input signal of the reception pass which spread the

minimum distance becomes the highest by this configuration, the input signal of the reception pass which spread the minimum distance can be chosen.
[0042] In the distance detection approach according to claim 1 to 8, the radio between a local station and a distant office of invention according to claim 15 is the radio of a TDMA method.
[0043] By this configuration, the distance detection using the distance detection approach according to claim 1 to 8 is attained in the radio of a TDMA method.
[0044] Invention according to claim 16 detects the gap with the slot reception anticipation timing from the distant office expected on the basis of the slot transmit timing assigned to the local station, and the slot receiving timing which received from the distant office actually as local station detection phase contrast in the distance detection approach according to claim 15.
[0045] By this configuration, local station detection phase contrast can be detected in the radio of a TDMA method, and a relative distance with a distant office can be detected.
[0046] Invention of the location specification approach according to claim 17 pinpoints the location of the Communication Bureau where a location has not become clear based on the relative-distance information which detected the relative distance between the Communication Bureau where a location has not become clear, and two or more Communication Bureau where the location has become clear, respectively, and detected it using the distance detection approach according to claim 1 to 16.
[0047] Invention of location recognition equipment according to claim 37 detects the relative distance between the Communication Bureau where a location has not become clear, and two or more Communication Bureau where the location has become clear using distance detection equipment according to claim 28 to 33, and pinpoints the location of the Communication Bureau where a location has not become clear based on the detected relative-distance information.
[0048] By this configuration, a location can detect the location of the Communication Bureau where a location is unknown by the communication link with the known Communication Bureau.
[0049] Invention of the location specification approach according to claim 18 pinpoints the location of a local station based on the relative-distance information which detected the relative distance between two or more distant offices the local station a location is not proved that it is, and the location are proved that they are, respectively, and detected it using the distance detection approach according to claim 1 to 16.
[0050] Invention of location recognition equipment according to claim 38 detects the relative distance between two or more distant offices the local station a location is not proved that it is, and the location are proved that they are using distance detection equipment according to claim 28 to 33, and pinpoints the location of a local station based on the detected relative-distance information.
[0051] By this configuration, distance with two or more distant offices can be detected, and it can use for location specification of a local station.
[0052] ** of the ****** specification approach according to claim 19 pinpoints the location of a distant office based on the relative-distance information which detected the relative distance between the local stations the distant office a location is not proved that it is, and the location are proved that they are, respectively, and detected it using the distance detection approach according to claim 1 to 16.
[0053] Invention of location recognition equipment according to claim 39 detects the relative distance between the local stations the distant office a location is not proved that it is, and the location are proved that they are using distance detection equipment according to claim 28 to 33, and pinpoints the location of a distant office based on the detected relative-distance information.
[0054] By this configuration, distance with a distant office can be detected and it can use for location specification of a distant office.
[0055] Using the distance detection approach according to claim 1 to 16, invention according to claim 20 shifts time amount, carries out multiple-times measurement of the relative distance of a local station and a distant office, is the relative-speed-detector approach of detecting the relative velocity of a local station and a distant office from the variation of the relative distance per unit time amount, and can detect the relative velocity of a local station and a distant office

easily.
[0056] It is the correspondence procedure which exchanges other information at the same time invention according to claim 21 performs distance detection by the distance detection approach according to claim 1 to 16 among two or more Communication Bureau, and there is an advantage which can carry out distance detection, without barring the communication link of other information.
[0057] Invention according to claim 22 is the transmitting PAWA control approach of performing transmitting PAWA control based on the distance information detected by the distance detection approach according to claim 9 to 16 among two or more Communication Bureau, and can realize high transmitting PAWA control of precision.
[0058] Invention of the timer gap detection approach according to claim 23 While the timer of a local station generates the signal of periodicity and transmitting to a distant office, the signal which generates the signal of periodicity with the timer of said distant office, and is transmitted to a local station from the distant office concerned is received. The distant-office detection phase contrast which shows the amount of gaps of the receiving timing of the sending signal from a local station and the criteria timing of the timer of a distant office which were detected by the distant office is acquired from said input signal. The local station detection phase contrast which shows the amount of gaps of the sending signal which transmitted to the distant office from the local station, and the input signal which received from the distant office is detected, and a gap of the timer of a local station and a distant office is detected from said local station detection phase contrast and said distant-office detection phase contrast.
[0059] By this configuration, since a gap of the timer of a local station and a distant office is detected from local station detection phase contrast and distant-office detection phase contrast, the amendment corresponding to a timer gap of a local station or a distant office is attained.
[0060] Invention according to claim 24 asks for a gap of the timer of a distant office in the timer gap detection approach according to claim 23 based on a degree type, and distant-office timer gap = (local station detection phase contrast-distant-office detection phase contrast) / 2 on the basis of the timer of a local station.
[0061] By this configuration, since a gap of the timer of a distant office is detectable from local station detection phase contrast and distant-office detection phase contrast, the processing which amended the gap of a timer with a distant office is attained.
[0062] In the timer gap detection approach [according to claim 25] according to claim 23, it asks for a gap of the timer of a local station based on a degree type, and local station timer gap = (distant-office detection phase contrast-local station detection phase contrast) / 2 on the basis of the timer of a distant office.
[0063] By this configuration, since a gap of the timer of a local station is detectable from local station detection phase contrast and distant-office detection phase contrast, the processing which amended the gap of a timer with a distant office is attained.
[0064] As for invention according to claim 26, the processing to which it amended the gap of the timer of the Communication Bureau in the spread-spectrum communication link in the timer gap detection approach according to claim 23 to 25 since the radio between a local station and a distant office was a spread-spectrum communication link is attained.
[0065] As for invention according to claim 27, the processing to which it amended the gap of the timer of the Communication Bureau in the radio of a TDMA method in the timer gap detection approach according to claim 23 to 25 since the radio between a local station and a distant office was the radio of a TDMA method is attained.
[0066] Invention according to claim 35 is the mobile equipped with distance detection equipment according to claim 28 to 33, and can realize the mobile equipped with the distance detection function by asynchronous transmission and reception.
[0067] Invention according to claim 36 is the fixed station equipped with distance detection equipment according to claim 28 to 33, and can realize the fixed station equipped with the distance detection function by asynchronous transmission and reception.
[0068] Invention according to claim 37 detects the relative distance between two or more

distant offices the local station a location is not proved that it is, and the location are proved that they are using distance detection equipment according to claim 28 to 33, and is location recognition equipment which pinpoints the location of a local station based on the detected relative-distance information.
[0069] Moreover, in location recognition equipment according to claim 37, while invention according to claim 40 receives the absolute positional information of two or more base stations to the base station used as a distant office, it detects a relative distance with a base station from the input signal, and pinpoints the absolute location of a local station from the absolute location of a circumference base station, and the relative distance to the base station.
[0070] Invention according to claim 41 is relative-speed-detector equipment which shifts time amount, carries out multiple-times measurement of the relative distance of a local station and a distant office using distance detection equipment according to claim 28 to 34, and detects the relative velocity of a local station and a distant office from the variation of the relative distance per unit time amount.
[0071] Invention according to claim 42 is mounted equipment equipped with location recognition equipment according to claim 37 or 40 or relative-speed-detector equipment according to claim 41.
[0072] Invention according to claim 43 is traffic information generation equipment which detects the relative distance or relative velocity of a local station and a distant office using distance detection equipment according to claim 28 to 34 or relative-speed-detector equipment according to claim 41, and generates traffic information using a detection result.
[0073] Invention of timer gap detection equipment according to claim 44 A transmitting means to generate the signal of periodicity with the timer of a local station, and to transmit to a distant office, A receiving means to receive the signal which generates the signal of periodicity with the timer of said distant office, and is transmitted to a local station from the distant office concerned, The configuration equipped with a timer gap detection means to detect the timer gap with a local station and a distant office using the phase contrast of the sending signal which transmitted to the distant office, and the input signal which received from the distant office from a local station is taken.
[0074] Since phase contrast (local station detection phase contrast) including a gap and the propagation-delay time of the criteria timing of a local station and a distant office performs timer gap detection according to this configuration, a local station and a distant office can realize high detection precision, without being able to carry out distance detection easily that what is necessary is for receiving timing to be respectively asynchronous at its own timer, and just to transmit and receive a signal, without having big effect on the communication link of other information, and receiving effect in synchronous precision at a distant office.
[0075]
[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained concretely.
[0076] (Gestalt 1 of operation) Functional block of the base station in which the radio of a CDMA method is possible, and a mobile station is shown in drawing 1 . It is the example which performs the base station and CDMA radio from which the mobile station used as a local station turns into a distant office with the gestalt of this operation, and detects the relative distance between base stations. Hereafter, the radio by the CDMA method is explained to an example as one of the spread-spectrum communication modes.
[0077] A base station 10 is equipped with the slide correlator 15 for restoring to the antenna 14 and input signal which receive a radio wave while it sends out the timer 12 which generates the clock of the base station side control section 11 which has a calculation function for communications control and range measurement, and the sample rate fs (period Ts) and the chip rate fc (period Tc), the diffusion circuit 13 which diffuses transmit data, and the diffused signal. The base station side control section 11 consists of a CPU, a DSP, memory, etc., and is equipped with the phase contrast detection function which is mentioned later in addition to an original base station function. The slide correlator 15 consists of a back-diffusion-of-electrons coder 16 which is made to shift a diffusion sign and is made to generate a back-diffusion-of-

electrons sign in order to take correlation with an input signal, and a back-diffusion-of-electrons circuit 17 which outputs the correlation value which multiplied the back-diffusion-of-electrons sign by the input signal.
[0078] On the other hand, the mobile station 20 is equipped with the functional block same for a spread-spectrum communication link as a base station 10. That is, it has the mobile station side control section 21, a timer 22, the diffusion circuit 23, an antenna 24, and the slide correlator 25. The mobile station control section 21 consists of a CPU, a DSP, memory, etc., and is equipped with the calculation function which detects the relative distance between a phase contrast detection function and a base station 10 in addition to an original mobile station function. The slide correlator 25 consists of a back-diffusion-of-electrons coder 26 which is made to shift a diffusion sign and is made to generate a back-diffusion-of-electrons sign in order to take correlation with an input signal, and a back-diffusion-of-electrons circuit 27 which outputs the correlation value which multiplied the back-diffusion-of-electrons sign by the input signal.
[0079] Actuation of the gestalt of this operation constituted as mentioned above is explained referring to the timing chart of drawing 2 and drawing 3 .
[0080] Drawing 2 shows the condition that the base station 10 and the mobile station 20 are carrying out the spread-spectrum communication link mutually based on the criteria timing which each timers 12 and 22 give.
[0081] In a base station 10, if transmit data is inputted into the diffusion circuit 13 from the base station side control section 11, transmit data will be spread at the predetermined chip rate fc by the diffusion sign C1 in the transmit timing which a timer 12 gives in the diffusion circuit 13, and wireless transmission will be carried out from an antenna 14.
[0082] At this time, the spread spectrum of the diffusion sign C1 is multiplied and carried out to transmit data in the diffusion circuit 13 with the clock fc of the chip rate which a timer 12 generates. The criteria timing of a timer 12 gives the timing which the head of the diffusion sign C1 for carrying out the spread spectrum of the transmit data generates. When the counted value of the clock fc of a timer 12 is 0, specifically, the diffusion sign C1 is generated so that the head of the diffusion sign C1 may be multiplied by transmit data. Moreover, when counted value is maximum, the last of the diffusion sign C1 is multiplied by transmit data, counted value is reset with the following clock, counted value is again set to 0, and he is trying for the head of the diffusion sign C1 to appear.
[0083] Thus, wireless transmission of the signal (spread-spectrum signal) in which the timer 12 built in the base station 10 has the periodicity generated based on the criteria timing given periodically is carried out to a mobile station 20. The signal by which wireless transmission was carried out from the base station 10 reaches at a mobile station 20 after the propagation time Td proportional to the distance between a mobile station 20 and a base station 10.
[0084] On the other hand, in a mobile station 20, the spread spectrum of the transmit data given to the diffusion circuit 23 from the mobile station side control section 21 like a base station 10 is carried out with the diffusion sign C2 based on the criteria timing which the timer 22 of a local station gives, and wireless transmission is carried out from an antenna 24.
[0085] Thus, wireless transmission of the signal (spread-spectrum signal) with the periodicity generated based on the criteria timing which the built-in timer 22 gives periodically to a mobile station 20 to a base station 10 also from the mobile station 20 is carried out to a base station 10. Since it will serve as the same propagation path if the transmission to a mobile station 20 from the above-mentioned base station 10 and the time progress of the time amount to which the signal by which wireless transmission was carried out from the mobile station 20 arrives at a base station 10 are small, it turns into the same propagation time Td.
[0086] In a mobile station 20, while the input signal received with the antenna 24 is inputted into the back-diffusion-of-electrons circuit 27, back-diffusion-of-electrons sign C1' which the back-diffusion-of-electrons coder 26 generated is inputted into the back-diffusion-of-electrons circuit 27. Back-diffusion-of-electrons sign C1' carries out the sequential shift of the same diffusion sign C1 as the diffusion sign used for the spread spectrum in the back-diffusion-of-electrons coder 26 by the transmitting side, and is generated. That is, as shown in drawing 2 , the counted value of the timer 22 of a local station doubles the head of the diffusion sign C1

with the timing (criteria timing) of 0, and a sequential shift is carried out with a sampling period Ts until counted value turns into maximum and is reset.
[0087] At this time, the correlation output CR of the data stream of an input signal and back-diffusion-of-electrons sign C1' is outputted to the mobile station side control section 21 from the back-diffusion-of-electrons circuit 27. The mobile station side control section 21 detects the time amount from which the biggest correlation output CR was obtained. This correlation processing is called diffusion pattern matching of the back diffusion of electrons.
[0088] Time amount until the maximum of the correlation output CR is obtained by diffusion pattern matching of the back diffusion of electrons in a mobile station 20 consists of timer gap time amount with the criteria timing of the timer 22 of the mobile station 20 used as the criteria timing of the timer 12 of the base station 10 used as a transmitting side, and a receiving side, and the above-mentioned propagation delay Td. Time amount until the maximum of the correlation output CR is obtained on the basis of the criteria timing which the timer 22 of a mobile station 20 gives is made into the phase contrast T2 as local station detection phase contrast.
[0089] Phase contrast T2 is searched for [count / until it detects the maximum correlation output for a sampling rate fs for N times (integer of N>=1) of the chip rate fc / of a shift / n] from a degree type.
[0090] Phase contrast T2=nxTs -- (1)
Moreover, the time amount = phase contrast T1 until the maximum of the correlation output CR is obtained on the basis of the criteria timing which the timer 12 of a base station 10 gives is detectable by performing diffusion pattern matching of the back diffusion of electrons based on the criteria timing which the timer 12 of a base station 10 gives the signal received from the mobile station 20 also in the base station 10. Phase contrast T1 turns into distant-office detection phase contrast.
[0091] The timer gaps T01 and T02 which are the time difference of phase contrast T1 and T2, a propagation delay Td, and criteria timing detected by drawing 3 with a base station 10 and a mobile station 20 are shown. As shown in this drawing, when the synchronization between the Communication Bureau (a base station, mobile station) cannot be taken, phase contrast Tn is expressed with a degree type, using a timer gap of the transmitting side on the basis of a receiving side as T0n.
[0092]
The transmitting-side synchronous gap T0n+ propagation time Td seen from the phase contrast Tn= receiving side -- (2)
When phase contrast when making phase contrast T2 and a mobile station 20 into a transmitting side, and making a base station 10 into a receiving side for the phase contrast when making T01 base station 10 into a transmitting side, and making a mobile station 20 into a receiving side for a gap of the timer 22 of the mobile station [gap / the timer 12 of the base station 10 on the basis of a mobile station 20] 20 on the basis of T02 base station 10 is made into phase contrast T1, there is relation of a bottom type.
[0093]
T02+ propagation-time Td= phase contrast T2 -- (3)
T01+ propagation-time Td= phase contrast T1 -- (4)
While 22 is advancing on the basis of the base station 10 only as for the timerT01 of a mobile station 20, when based reverse on a mobile station 20, only base station 10 timerT02 will be behind in 12.
[0094] Therefore, if there is relation of T01=-T02 and a formula (3) and a formula (4) are added, a timer gap of left part denies and there is, and only the propagation time Td can remain in left part, and can compute the distance L between a base station 10 and a mobile station 20.
[0095]
Propagation-time Td= (phase contrast T1+ phase contrast T2)/2 -- (5)
Distance L= velocity-of-light x (phase contrast T1+ phase contrast T2)/2 -- (6)
Moreover, if a formula (3) and a formula (4) are subtracted, the propagation time Td of left part denies and there is, and only a timer gap can remain in left part and can compute a gap of a

synchronization.
[0096]
T01= (phase contrast T1-phase contrast T2)/2 -- (7)
T02= (phase contrast T2-phase contrast T1)/2 -- (8)
If it amends by the gap of the computed timer, distance L can also be found by the bottom formula.
[0097]
Distance L= velocity-of-light x (phase contrast T1-timer gap T01) -- (9)
Distance L= velocity-of-light x (phase contrast T2-timer gap T02) -- (10)
With the gestalt of this operation, when a mobile station 20 measures the distance to a base station 10, it transmits to a mobile station 20 from a base station 10 by using as transmit data phase contrast T01 detected based on the criteria timing of its own timer 12 in the base station 10 which received the signal from a mobile station 20.
[0098] In a mobile station 20, the phase contrast T01 which restored to the received data about the phase contrast T01 received from the base station 10, and was detected in the base station 10 is acquired. On the other hand, diffusion pattern matching of the back diffusion of electrons with the received data about the phase contrast T01 concerned detects the phase contrast T2 based on the criteria timing of the timer 22 of a local station.
[0099] In the mobile station side control section 21, the distance L from a mobile station 20 to a base station 10 is calculated based on the above-mentioned formula (6). Or you may make it calculate a relative distance L by the above-mentioned formula (7) and the above-mentioned formula (8) detecting the timer gap T02 of the base station 10 on the basis of a mobile station 20, or the timer gap T01 of the mobile station 20 on the basis of a base station 10, and amending a part for a timer gap based on a formula (9) or a formula (10).
[0100] Moreover, the timers 22 and 12 of a mobile station 20 and a base station 10 are set using the timer gaps T01 or T02 calculated by the formula (7) or the formula (8). For example, in a base station 10, the base station side control section 11 sets a timer 12 only for the timer gap T02 when being based on the timer 22 of a mobile station 20. In a mobile station 20, it is the same, and a lump activity may be done.
[0101] After losing a timer gap, you may make it calculate a relative distance L in a degree type.
[0102] Distance L= velocity-of-light x phase contrast -- (11)
Next, the range error calculated based on phase contrast is explained.
[0103] Drawing 4 is the graph which indicated the relation of the correlation output P when carrying out the back diffusion of electrons to be said phase contrast T and shift-hours t of the diffusion code C by slide correlator (15 25) by the back-diffusion-of-electrons sign C'. In this drawing, shift-hours [of the diffusion code C according / an axis of abscissa / to slide correlator] t and an axis of ordinate are the correlation outputs P. In order to simplify explanation, the sample rate fs (period Ts) and the chip rate fc (period Tc) of drawing are considered as the relation of fs/fc=1.
[0104] As a description of the diffusion sign used for a spread-spectrum communication link, the maximum correlation output Pmax is obtained for shift-hours t at the time of 0, and difference deltat of the phase contrast T of a diffusion sign decreases in proportion to the absolute value of deltat, and if the absolute value of deltat becomes more than Tc, it will almost be set to 0. If it is made a formula, it will become a formula (12) and a formula (13).
[0105]
At the time of T-Tc<=t<=T P=(Pmax/Tc)x(t-T)+Pmax -- (12)
At the time of T<=t<=T+Tc P=-(Pmax/Tc)x(t-T)+Pmax -- (13)
Phase contrast T is detectable in approximation with the shift hours Tn in case a correlation output is max.
[0106] When the shift hours Tn in case a correlation output is max, and a difference with phase contrast T become max, it is a time of phase contrast T existing in the core of the sample period Ts. Since a range error delta x applies a time error and the velocity of light, if deltax<=cxTs/2 velocity-of-light c=3.0x108[m] sample rate fs=15MHz=1.5x107[/ second], it will become deltax <=10[m].

[0107] Furthermore, in order to raise phase contrast detection precision, deed phase contrast can be searched for for an approximation calculation to the correlation function of a formula (12) and (13) using the value of the sample beyond a value with a fixed correlation output. In the example of drawing 4, the sampled value of (tm, Pm), and (Tn, Pn) is used. If (tm, Pm) are substituted for a formula (12) and (Tn, Pn) are substituted for a formula (13), since the number of linear expressions is two, phase contrast T can be searched for from binary [of Unknowns T and Pmax].
[0108] In the example of drawing 4, since it is Tn=Tm+Ts=Tm+Tc, count becomes easy and phase contrast T can be found by count of a formula (14).
[0109]
T=Tn- {P1Tc/(P1+P2)} -- Supposing the error of a sampling period Ts can disregard the error of (14) correlation output P to the error of a correlation output 10%, the error of T becomes 10% of order of Ts, and at the time of fs=15MHz, the error of distance will become 1 [m] order and will become 10 [cm] order at the time of fs=150MHz. Although it was referred to as fs/fc=1 in order to simplify explanation, as for approximation, the way which took large fs/fc becomes accuracy more.
[0110] Since a distant office (base station 10) detects time difference (phase contrast T2) with criteria timing with the timer 22 of a local station (mobile station 20) from the signal which carried out spectrum diffusion and which has been transmitted with the timer 12 of a distant office and enabled it to detect distance from phase contrast T2 according to the gestalt of such operation, the base station 10 of the signal from the mobile office 20 is asynchronous, and can perform data communication. Moreover, since it is not premised on a distant office carrying out synchronous transmission, the dependability of distance detection precision improves.
[0111] In addition, although the gestalt 1 of the above-mentioned implementation explained the distance detection and timer gap detection between a base station 1 and a mobile station 20, it can apply also like distance detection of mobile stations and timer gap detection of an automobile etc., and can carry out. Between the vehicles of mobiles, such as an automobile, can be detected and the vehicles detection information can be used as control information of a mobile. Moreover, the vehicles detection information which the mobile detected can be sent to a traffic control system, and it can also use for generation of delay information etc.
[0112] (Gestalt 2 of operation) It has the function which chooses from a base station 10 the input signal of the electric wave which spread the minimum distance as the mobile station 20 explained with the gestalt 1 of the above-mentioned implementation.
[0113] As shown in drawing 5, when a mobile station 20 exists under the site condition in which a building (obstruction) exists, a mobile station 20 also receives to coincidence the electric wave which reflected in the building other than the electric wave which spread the slant range between a base station 10 and a mobile station 20 (minimum distance), and was spread.
[0114] At this time, the electric wave which spread the slant range between a base station 10 and a mobile station 20 (minimum distance) reaches a mobile station 20 early most, as shown in drawing 6, and attenuation of that electric wave is the smallest. Therefore, in the mobile station 20 used as a receiving station, the signal which has spread the minimum distance is most detected by the criteria timing of a timer 22 as most near and high pass of receiving level in two or more reception pass.
[0115] With the gestalt of this operation, it considers that the earliest reception pass of timing spread the minimum distance between the Communication Bureau, and the reception pass by the reflected wave is removed from two or more detected reception pass. Or it considers that the high reception pass of receiving level spread the minimum distance between the Communication Bureau most, and the reception pass by the reflected wave is removed from two or more detected reception pass. Or most near and the high pass of receiving level are most chosen as the criteria timing of a timer in two or more reception pass.
[0116] According to the gestalt of such operation, since the reception pass by the reflected wave is efficiently removable, phase contrast detection can be performed based on the signal which spread the minimum distance, and timer gap detection can be performed.
[0117] (Gestalt 3 of operation) Other information is made to communicate among the

Communication Bureau with the gestalt of this operation at the same time it performs ranging based on the distance detection method mentioned above among the Communication Bureau which carried the CDMA transmitter. The information exchanged to distance detection or timer gap detection, and coincidence among the Communication Bureau is arbitrary.
[0118] As shown in drawing 7, Mobile A and Mobile C presuppose that the mobile B which does not belong to the same group is pinched among Mobiles A and C by the same group. Mobile C not only detects the phase contrast of the signal from Mobile A, but receives to coincidence the car information on the mobile [Mobile / A] A by which wireless transmission is carried out (for example, car number). And it judges whether the mobile B which runs the front belongs to a self-vehicle and the same group. Mobile C follows Mobile A based on the car information on Mobile A.

[0119] Since it is not necessary to return a response wave synchronizing with the input signal from a distant office in order to measure the distance between the Communication Bureau, according to the gestalt of such this operation, the information besides coincidence other than distance detection or timer gap detection can be transmitted and received.
[0120] (Gestalt 4 of operation) The gestalt of this operation is the example of the relative-speed-detector equipment which detects the relative velocity between cars for ranging based on the distance detection method mentioned above between the cars carrying a CDMA transmitter from the difference of a multiple-times deed and the relative distance at that time, and the time difference of the timing of ranging.
[0121] As shown in drawing 8, while Cars A and B are moving on the same straight line, multiple-times activation of the distance detection is carried out by the same method as the mobile station of the gestalt 1 of operation mentioned above by Car A. By Car A, the relative velocity between the cars B in current is detected based on a bottom type.
[0122]
Relative-velocity V=(r2-r1)/(t2-t1) (15)
However, the relative distance by which r1 was detected by ranging in time of day t1, and r2 are the relative distances detected by ranging in time of day t2.
[0123] According to the gestalt of such this operation, relative velocity with a distant office is detectable using the detected relative distance.
[0124] (Gestalt 5 of operation) The gestalt of this operation is the example of the CDMA radio communication equipment which performs ranging of the distance detection method transmitted, received and mentioned above in the spread-spectrum communication mode, and determines transmitting power based on the relative-distance information at that time.
[0125] Therefore propagation distance becomes long, energy diffuses and decreases the electric wave which spreads space. The attenuation factor of a signal serves as a monotonically decreasing function of the relative distance between the Communication Bureau. The relative distance measured to the theoretical formula or empirical formula of said function is applied, an attenuation factor is searched for, and the receiving level of the Communication Bureau of a receiving side is controlled by adjusting the transmitted power of the Communication Bureau of a transmitting side.
[0126] According to the gestalt of such this operation, based on the distance information acquired by distance detection, transmitted power is controllable to a suitable value.
[0127] (Gestalt 6 of operation) The gestalt of this operation is an example using TDMA communication system as a system which transmits and receives a signal with periodicity.
[0128] As shown in drawing 9, a TDMA communication mode is communication system with which each Communication Bureau transmits to the predetermined timing assigned for every Communication Bureau the fixed period. The predetermined timing (slots A, B, and C) assigned by the TDMA method has given the allowances in consideration of the delay of the propagation time by the distance between the Communication Bureau, and each Communication Bureau transmits a signal to asynchronous in the range of these allowances.
[0129] The timing chart between the Communication Bureau A and B is shown in drawing 10. The Communication Bureau A and B will do wireless transmission of the transmit data, if the criteria timing (slot A transmit timing, slot B transmit timing) given with the timer which each one

has comes.

[0130] In the Communication Bureau A to which Slot A was assigned as transmit timing, the Communication Bureau B to which Slot B was assigned as transmit timing can expect the receiving timing (slot B reception anticipation timing) of transmit data which transmitted by Slot B based on its own timer. In the example of drawing 10 , the Communication Bureau A makes time amount TAB slot B reception anticipation timing. And slot B receiving timing tA' which actually received Slot B is detected.

[0131] With the gestalt of this operation, phase contrast tA is searched for in a degree type in the Communication Bureau A from time amount tA' until slot B receiving timing is detected from slot A transmit timing based on the timer of the Communication Bureau A, and the time amount TAB until it results [from slot A transmit timing] in slot B reception anticipation timing.

[0132]

Phase contrast tA= time amount tA'- Time amount TAB — (16-1)

Here, the phase contrast tA calculated will have the same semantics as the phase contrast T1 and T2 of the gestalt of operation described above since it was the time amount which consists of a propagation delay between the Communication Bureau A and B, and a timer gap. Therefore, the same distance detection as a gestalt 1 and timer gap detection of operation are attained by searching for phase contrast tB from a degree type similarly in the Communication Bureau B.

[0133]

Phase contrast tB= time amount tB'+ time amount TAB — (16-2)

(Gestalt 7 of operation) The gestalt of this operation is the example of the location specification equipment which pinpoints a location absolutely of the Communication Bureau where a location is unspecified using the above-mentioned distance detection method. Any of CDMA or a TDMA method are sufficient as a communication mode.

[0134] It explains with reference to drawing 11 . It radiocommunicates between two or more base stations B1 where it moved and the mobile station A and location where a location is unspecified have become clear by immobilization with time amount, B-2, and B3. In order to simplify explanation, a mobile station A, a base station B1, B-2, and B3 presuppose that it exists on the surface of the earth it can be considered substantially that is a flat surface. Moreover, the position coordinate of (X2, Y2), and a base station B3 is set [the position coordinate of a mobile station A / the position coordinate of (x, y) and a base station B1] to (X3, Y3) for the position coordinate of (X1, Y1), and base station B-2.

[0135] A mobile station A detects relative distances R1, R2, and R3 by the distance detection method shown in the gestalt of said operation by three base stations B1, B-2, and the radio of B3. The relation of a formula (17), a formula (18), and a formula (19) between position coordinates is with the above-mentioned relative distances R1, R2, and R3.

[0136]

(x-X1) 2+(y-Y1)2=R12 — (17)

(x-X2) 2+(y-Y2)2=R22 — (18)

(x-X3) 2+(y-Y3)2=R32 — (19)

From three secondary types, since an unknown is binary [of x and y], it can ask for x and y from a formula (17), a formula (18), and a formula (19).

[0137]

[Effect of the Invention] According to this invention, a sending station and a receiving station are asynchronous, and as a full account was given above, as the signal respectively generated with the timer of a local station can be transmitted and received, while being able to communicate other information to coincidence, the distance detection approach which enabled the reliable distance detection and timer gap detection which do not receive effect in the synchronous precision of a receiving station, and its equipment can be offered.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] This invention relates to the distance detection approach especially applicable to the mobile communication system of a spread-spectrum communication mode, and its equipment about the suitable distance detection [to detect the relative distance between mobile stations or between a mobile station and a base station] approach, and its equipment.

[Translation done.]

PRIOR ART

[Description of the Prior Art] Recently, the ranging system which detects the relative distance of two mobiles using a spread-spectrum communication mode is developed. for example, the transmission wave in which certain Communication Bureau (self-vehicle) MS-11 carried out the diffusion modulation in the communication device between cars given in JP,5-122120,A other Communication Bureau (other vehicles) MS-2 — wireless transmission — carrying out — Communication Bureau MS-2 besides the above — the account of a top — the transmission wave which carried out the diffusion modulation with the diffusion sign which synchronized with the diffusion sign when the transmission wave by which the diffusion modulation was carried out from certain Communication Bureau MS-1 was received — the account of a top — it returns to certain Communication Bureau MS-11. When other response waves from Communication Bureau MS-2 are received, certain Communication Bureau MS-1 detected time difference after transmitting a transmission wave from Communication Bureau MS-1 until it receives a response wave from other Communication Bureau MS-2, and it has detected the relative distance between [of two] the Communication Bureau by the formula (1).
[0003]
Relative distance = velocity-of-light x time difference / 2 — (1)

[Translation done.]

* NOTICES *

JPO and NCIPI are not responsible for any
damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

EFFECT OF THE INVENTION

[Effect of the Invention] According to this invention, a sending station and a receiving station are asynchronous, and as a full account was given above, as the signal respectively generated with the timer of a local station can be transmitted and received, while being able to communicate other information to coincidence, the distance detection approach which enabled the reliable distance detection and timer gap detection which do not receive effect in the synchronous precision of a receiving station, and its equipment can be offered.

[Translation done.]

* NOTICES *

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] In the communication device between cars mentioned above, if a receiving station receives the transmission wave from a sending station, it is premised on the head of a diffusion sign carrying out the diffusion modulation of the response wave returned to a sending station with the diffusion (it having synchronized) sign which was mostly in agreement with receiving timing, and transmitting. For this reason, since it is forced to make the receiving station to which a response wave is returned generate a diffusion sign synchronizing with a received wave, and to return a response wave to it, it is difficult to carry various data in the communication device which communicates by the CDMA method in addition to range measurement.
[0005] Moreover, since distance detection is performed on the assumption that the response wave diffused with the diffusion sign to which the receiving station synchronized with the received wave in the sending station is returned, the synchronous precision of a receiving station will have direct effect on distance detection precision.
[0006] This invention is made in view of the above actual condition, and a sending station and a receiving station are asynchronous with the diffusion sign which makes it generate with the timer of a local station respectively, and as a signal can be transmitted and received, while being able to communicate other information to coincidence, it aims at offering the distance detection approach which enabled distance detection with the high dependability which is not influenced, and its equipment for the synchronous precision of a receiving station.

[Translation done.]

* NOTICES *

JPO and NCIPI are not responsible for any
damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

MEANS

[Means for Solving the Problem] This invention provided the following means, in order to solve the above-mentioned technical problem.
[0008] While invention of the distance detection approach according to claim 1 transmits the signal which has periodicity based on the criteria timing generated with the timer which the Communication Bureau A has to the Communication Bureau B The Communication Bureau B which received the sending signal of the Communication Bureau A receives the signal generated and transmitted based on the criteria timing generated in the interior, detects the phase contrast of said sending signal and input signal, and detected the distance between the Communication Bureau A and the Communication Bureau B.
[0009] High detection precision can be realized without being able to carry out distance detection easily that the Communication Bureau of receiving timing is respectively asynchronous at its own timer, and should transmit [just] and receive a signal since phase contrast including a gap and the propagation-delay time of the criteria timing of the Communication Bureau and the Communication Bureau performs distance detection, without having big effect on the communication link of other information, and receiving effect in synchronous precision by this configuration, at a distant office.
[0010] While invention of the distance detection approach according to claim 2 generated the signal of periodicity with the timer of a local station and transmitted to the distant office, it receives the signal which generates the signal of periodicity with the timer of said distant office, and is transmitted to a local station from the distant office concerned, and detected the relative distance of a local station and a distant office using the phase contrast of the sending signal which transmitted to the distant office from the local station, and the input signal which received from the distant office.
[0011] Moreover, invention of distance detection equipment according to claim 28 A transmitting means to generate the signal of periodicity with the timer of a local station, and to transmit to a distant office, A receiving means to receive the signal which generates the signal of periodicity with the timer of said distant office, and is transmitted to a local station from the distant office concerned, The configuration possessing a distance detection means to detect the relative distance of a local station and a distant office using the phase contrast of the sending signal which transmitted to the distant office, and the input signal which received from the distant office from a local station is taken.
[0012] High detection precision can be realized without being able to carry out distance detection easily that a local station and the distant office of receiving timing are respectively asynchronous at their own timer, and should transmit [just] and receive a signal since phase contrast (local station detection phase contrast) including a gap and the propagation-delay time of the criteria timing of a local station and a distant office performs distance detection, without having big effect on the communication link of other information, and receiving effect in synchronous precision by these configurations, at a distant office.
[0013] Invention according to claim 3 made the signal of the periodicity which a distant office generates the signal of the same period as a sending signal in the distance detection approach of claim 2.

[0014] Moreover, invention according to claim 29 made the signal of the periodicity which a distant office generates the signal of the same period as a sending signal in distance detection equipment according to claim 28.
[0015] By this configuration, distance detection is attained by the radio by the spectrum spread system and the TDMA method which transmit and receive the signal of the periodicity of the same period as an input signal.
[0016] The distant-office detection phase contrast to which invention according to claim 4 detected the amount of gaps of the receiving timing and the criteria timing of the timer of a distant office which received the sending signal from a local station by the distant office as phase contrast in a distant office in the distance detection approach according to claim 2, The local station detection phase contrast which detected the amount of gaps of the receiving timing and the criteria timing of the timer of a local station which received the sending signal from a distant office by the local station as phase contrast in a local station is used for relative-distance detection.
[0017] Moreover, invention according to claim 30 is set to distance detection equipment according to claim 28. A local station phase contrast detection means by which a distance detection means detects the amount of gaps of the receiving timing and the criteria timing of the timer of a local station which received the sending signal from a distant office as local station detection phase contrast, The configuration which has a distant-office phase contrast detection means to restore the distant-office detection phase contrast which shows the amount of gaps of the receiving timing and the criteria timing of the timer of a distant office which were detected by the distant office from the input signal which received from the distant office is taken.
[0018] Since distance detection can be carried out by these configurations using the phase contrast detected by the distant office, and the phase contrast detected by the local station, a local station and the distant office of receiving timing are respectively asynchronous at their own timer, and can transmit and receive a signal.
[0019] Invention according to claim 5 restores to the input signal which received from the distant office in the distance detection approach according to claim 4, and acquires distant-office detection phase contrast. The configuration which detects based on the constant by which degree type and relative-distance =Kx (distant-office detection phase contrast + local station detection phase contrast)/2, however :K are equivalent to the velocity of light in the relative distance of a local station and a distant office is taken using said distant-office detection phase contrast and the local station detection phase contrast detected by the local station.
[0020] Since distance detection can be carried out by this configuration using the phase contrast detected by the distant office, and the phase contrast detected by the local station, a local station and the distant office of receiving timing are respectively asynchronous at their own timer, and can transmit and receive a signal.
[0021] In the distance detection approach according to claim 4, invention according to claim 6 restores to the input signal which received from the distant office, acquires distant-office detection phase contrast, and detects the gap with the criteria timing of the timer of a local station, and the criteria timing of the timer of a distant office using said distant-office detection phase contrast and the local station detection phase contrast detected by the local station.
[0022] Moreover, invention according to claim 31 takes a configuration equipped with a timer gap detection means to detect the gap with the criteria timing of the timer of a local station, and the criteria timing of the timer of a distant office using distant-office detection phase contrast and local station detection phase contrast, in distance detection equipment according to claim 30.
[0023] By this configuration, since the gap with the criteria timing of the timer of a local station and the criteria timing of the timer of a distant office is detectable using distant-office detection phase contrast and local station detection phase contrast, a timer gap of a local station and a distant office can be amended easily.
[0024] After invention according to claim 7 doubles the conventional time of the timer of a local station, and the timer of a distant office in the distance detection approach according to claim 6

based on a gap of the detected criteria timing, a degree type, relative-distance =Kx local station detection phase contrast, however :K detect the relative distance of a local station and a distant office based on the constant equivalent to the velocity of light.
[0025] Moreover, after, as for invention according to claim 33, a distance detection means doubles the conventional time of the timer of a local station, and the timer of a distant office in distance detection equipment according to claim 31 based on a gap of the criteria timing which the timer gap detection means detected, the configuration which calculates the relative distance of a local station and a distant office based on the constant by which a degree type, relative-distance =Kx local station detection phase contrast, however :K are equivalent to the velocity of light is taken.
[0026] By this configuration, after doubling the conventional time of the timer of a local station, and the timer of a distant office, distance detection can be carried out only by detecting local station detection phase contrast, and improvement in the speed of distance detection can be attained.
[0027] In the distance detection approach according to claim 6, invention according to claim 8 considers a gap of the criteria timing of a distant office as a distant-office timer gap, after detecting a gap of the criteria timing of the distant office on the basis of the timer of a local station, and it is the relative distance of a local station and a distant office Degree type and relative-distance =Kx (local station detection phase contrast-distant-office timer gap) however, : — K is detected based on the constant equivalent to the velocity of light.
[0028] By this configuration, after detecting a gap of the criteria timing of a distant office, distance detection can be carried out only by detecting local station detection phase contrast, and improvement in the speed of distance detection can be attained.
[0029] In the distance detection approach according to claim 1 to 8, the radio between a local station and a distant office of invention according to claim 9 is a spread-spectrum communication link.
[0030] Moreover, in distance detection equipment according to claim 28 to 33, the radio between a local station and a distant office of invention according to claim 34 is the radio of spectrum spread system or a TDMA method.
[0031] The distance detection which used the above-mentioned phase contrast by this configuration is realizable on spectrum spread system or a TDMA method.
[0032] Invention according to claim 10 shifts relatively the back-diffusion-of-electrons sign which synchronized with the criteria timing of the timer of a local station to the input signal which carried out the diffusion modulation synchronizing with the criteria timing of the timer of a distant office, detects the correlation value of said input signal and said diffusion sign, and searches for local-station detection phase contrast in the distance detection approach according to claim 9 based on the count of a shift which showed the greatest correlation value, and the shift amount per time.
[0033] By this configuration, when performing a spread-spectrum communication link, slide correlator etc. can be used and local station detection phase contrast can be searched for easily.
[0034] Invention according to claim 11 chooses the correlation value beyond a predetermined value in the distance detection approach according to claim 10, and local station detection phase contrast is searched for by performing an approximation calculation to the autocorrelation function of a diffusion sign using said selection correlation value.
[0035] By this configuration, local station detection phase contrast with a high precision can be searched for by performing an approximation calculation to the autocorrelation function of a diffusion sign.
[0036] In the distance detection approach according to claim 1 to 11, out of two or more detected reception pass, invention according to claim 12 chooses the reception pass which spread the minimum distance between a local station and a distant office, and performs distance detection using the selected input signal of reception pass.
[0037] Since the input signal of the reception pass which spread the minimum distance is used for distance detection by this configuration, exact distance detection is attained.

[0038] In the distance detection approach according to claim 12, invention according to claim 13 chooses the reception pass of the earliest timing out of two or more detected reception pass, and performs distance detection.
[0039] Since the input signal of the reception pass which spread the minimum distance is received to the earliest timing by this configuration, the input signal of the reception pass which spread the minimum distance can be chosen.
[0040] In the distance detection approach according to claim 12, invention according to claim 14 chooses the high reception pass of receiving level most from two or more detected reception pass, and performs distance detection.
[0041] Since the receiving level of the input signal of the reception pass which spread the minimum distance becomes the highest by this configuration, the input signal of the reception pass which spread the minimum distance can be chosen.
[0042] In the distance detection approach according to claim 1 to 8, the radio between a local station and a distant office of invention according to claim 15 is the radio of a TDMA method.
[0043] By this configuration, the distance detection using the distance detection approach according to claim 1 to 8 is attained in the radio of a TDMA method.
[0044] Invention according to claim 16 detects the gap with the slot reception anticipation timing from the distant office expected on the basis of the slot transmit timing assigned to the local station, and the slot receiving timing which received from the distant office actually as local station detection phase contrast in the distance detection approach according to claim 15.
[0045] By this configuration, local station detection phase contrast can be detected in the radio of a TDMA method, and a relative distance with a distant office can be detected.
[0046] Invention of the location specification approach according to claim 17 pinpoints the location of the Communication Bureau where a location has not become clear based on the relative-distance information which detected the relative distance between the Communication Bureau where a location has not become clear, and two or more Communication Bureau where the location has become clear, respectively, and detected it using the distance detection approach according to claim 1 to 16.
[0047] Invention of location recognition equipment according to claim 37 detects the relative distance between the Communication Bureau where a location has not become clear, and two or more Communication Bureau where the location has become clear using distance detection equipment according to claim 28 to 33, and pinpoints the location of the Communication Bureau where a location has not become clear based on the detected relative-distance information.
[0048] By this configuration, a location can detect the location of the Communication Bureau where a location is unknown by the communication link with the known Communication Bureau.
[0049] Invention of the location specification approach according to claim 18 pinpoints the location of a local station based on the relative-distance information which detected the relative distance between two or more distant offices the local station a location is not proved that it is, and the location are proved that they are, respectively, and detected it using the distance detection approach according to claim 1 to 16.
[0050] Invention of location recognition equipment according to claim 38 detects the relative distance between two or more distant offices the local station a location is not proved that it is, and the location are proved that they are using distance detection equipment according to claim 28 to 33, and pinpoints the location of a local station based on the detected relative-distance information.
[0051] By this configuration, distance with two or more distant offices can be detected, and it can use for location specification of a local station.
[0052] ** of the ****** specification approach according to claim 19 pinpoints the location of a distant office based on the relative-distance information which detected the relative distance between the local stations the distant office a location is not proved that it is, and the location are proved that they are, respectively, and detected it using the distance detection approach according to claim 1 to 16.
[0053] Invention of location recognition equipment according to claim 39 detects the relative distance between the local stations the distant office a location is not proved that it is, and the

location are proved that they are using distance detection equipment according to claim 28 to 33, and pinpoints the location of a distant office based on the detected relative-distance information.
[0054] By this configuration, distance with a distant office can be detected and it can use for location specification of a distant office.
[0055] Using the distance detection approach according to claim 1 to 16, invention according to claim 20 shifts time amount, carries out multiple-times measurement of the relative distance of a local station and a distant office, is the relative-speed-detector approach of detecting the relative velocity of a local station and a distant office from the variation of the relative distance per unit time amount, and can detect the relative velocity of a local station and a distant office easily.
[0056] It is the correspondence procedure which exchanges other information at the same time invention according to claim 21 performs distance detection by the distance detection approach according to claim 1 to 16 among two or more Communication Bureau, and there is an advantage which can carry out distance detection, without barring the communication link of other information.
[0057] Invention according to claim 22 is the transmitting PAWA control approach of performing transmitting PAWA control based on the distance information detected by the distance detection approach according to claim 9 to 16 among two or more Communication Bureau, and can realize high transmitting PAWA control of precision.
[0058] Invention of the timer gap detection approach according to claim 23 While the timer of a local station generates the signal of periodicity and transmitting to a distant office, the signal which generates the signal of periodicity with the timer of said distant office, and is transmitted to a local station from the distant office concerned is received. The distant-office detection phase contrast which shows the amount of gaps of the receiving timing of the sending signal from a local station and the criteria timing of the timer of a distant office which were detected by the distant office is acquired from said input signal. The local station detection phase contrast which shows the amount of gaps of the sending signal which transmitted to the distant office from the local station, and the input signal which received from the distant office is detected, and a gap of the timer of a local station and a distant office is detected from said local station detection phase contrast and said distant-office detection phase contrast.
[0059] By this configuration, since a gap of the timer of a local station and a distant office is detected from local station detection phase contrast and distant-office detection phase contrast, the amendment corresponding to a timer gap of a local station or a distant office is attained.
[0060] Invention according to claim 24 asks for a gap of the timer of a distant office in the timer gap detection approach according to claim 23 based on a degree type, and distant-office timer gap = (local station detection phase contrast-distant-office detection phase contrast) / 2 on the basis of the timer of a local station.
[0061] By this configuration, since a gap of the timer of a distant office is detectable from local station detection phase contrast and distant-office detection phase contrast, the processing which amended the gap of a timer with a distant office is attained.
[0062] In the timer gap detection approach [according to claim 25] according to claim 23, it asks for a gap of the timer of a local station based on a degree type, and local station timer gap = (distant-office detection phase contrast-local station detection phase contrast) / 2 on the basis of the timer of a distant office.
[0063] By this configuration, since a gap of the timer of a local station is detectable from local station detection phase contrast and distant-office detection phase contrast, the processing which amended the gap of a timer with a distant office is attained.
[0064] As for invention according to claim 26, the processing to which it amended the gap of the timer of the Communication Bureau in the spread-spectrum communication link in the timer gap detection approach according to claim 23 to 25 since the radio between a local station and a distant office was a spread-spectrum communication link is attained.
[0065] As for invention according to claim 27, the processing to which it amended the gap of the

timer of the Communication Bureau in the radio of a TDMA method in the timer gap detection approach according to claim 23 to 25 since the radio between a local station and a distant office was the radio of a TDMA method is attained.
[0066] Invention according to claim 35 is the mobile equipped with distance detection equipment according to claim 28 to 33, and can realize the mobile equipped with the distance detection function by asynchronous transmission and reception.
[0067] Invention according to claim 36 is the fixed station equipped with distance detection equipment according to claim 28 to 33, and can realize the fixed station equipped with the distance detection function by asynchronous transmission and reception.
[0068] Invention according to claim 37 detects the relative distance between two or more distant offices the local station a location is not proved that it is, and the location are proved that they are using distance detection equipment according to claim 28 to 33, and is location recognition equipment which pinpoints the location of a local station based on the detected relative-distance information.
[0069] Moreover, in location recognition equipment according to claim 37, while invention according to claim 40 receives the absolute positional information of two or more base stations to the base station used as a distant office, it detects a relative distance with a base station from the input signal, and pinpoints the absolute location of a local station from the absolute location of a circumference base station, and the relative distance to the base station.
[0070] Invention according to claim 41 is relative-speed-detector equipment which shifts time amount, carries out multiple-times measurement of the relative distance of a local station and a distant office using distance detection equipment according to claim 28 to 34, and detects the relative velocity of a local station and a distant office from the variation of the relative distance per unit time amount.
[0071] Invention according to claim 42 is mounted equipment equipped with location recognition equipment according to claim 37 or 40 or relative-speed-detector equipment according to claim 41.
[0072] Invention according to claim 43 is traffic information generation equipment which detects the relative distance or relative velocity of a local station and a distant office using distance detection equipment according to claim 28 to 34 or relative-speed-detector equipment according to claim 41, and generates traffic information using a detection result.
[0073] Invention of timer gap detection equipment according to claim 44 A transmitting means to generate the signal of periodicity with the timer of a local station, and to transmit to a distant office, A receiving means to receive the signal which generates the signal of periodicity with the timer of said distant office, and is transmitted to a local station from the distant office concerned, The configuration equipped with a timer gap detection means to detect the timer gap with a local station and a distant office using the phase contrast of the sending signal which transmitted to the distant office, and the input signal which received from the distant office from a local station is taken.
[0074] Since phase contrast (local station detection phase contrast) including a gap and the propagation-delay time of the criteria timing of a local station and a distant office performs timer gap detection according to this configuration, a local station and a distant office can realize high detection precision, without being able to carry out distance detection easily that what is necessary is for receiving timing to be respectively asynchronous at its own timer, and just to transmit and receive a signal, without having big effect on the communication link of other information, and receiving effect in synchronous precision at a distant office.
[0075]
[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained concretely.
[0076] (Gestalt 1 of operation) Functional block of the base station in which the radio of a CDMA method is possible, and a mobile station is shown in drawing 1 . It is the example which performs the base station and CDMA radio from which the mobile station used as a local station turns into a distant office with the gestalt of this operation, and detects the relative distance between base stations. Hereafter, the radio by the CDMA method is explained to an example as

one of the spread-spectrum communication modes.
[0077] A base station 10 is equipped with the slide correlator 15 for restoring to the antenna 14 and input signal which receive a radio wave while it sends out the timer 12 which generates the clock of the base station side control section 11 which has a calculation function for communications control and range measurement, and the sample rate fs (period Ts) and the chip rate fc (period Tc), the diffusion circuit 13 which diffuses transmit data, and the diffused signal. The base station side control section 11 consists of a CPU, a DSP, memory, etc., and is equipped with the phase contrast detection function which is mentioned later in addition to an original base station function. The slide correlator 15 consists of a back-diffusion-of-electrons coder 16 which is made to shift a diffusion sign and is made to generate a back-diffusion-of-electrons sign in order to take correlation with an input signal, and a back-diffusion-of-electrons circuit 17 which outputs the correlation value which multiplied the back-diffusion-of-electrons sign by the input signal.
[0078] On the other hand, the mobile station 20 is equipped with the functional block same for a spread-spectrum communication link as a base station 10. That is, it has the mobile station side control section 21, a timer 22, the diffusion circuit 23, an antenna 24, and the slide correlator 25. The mobile station control section 21 consists of a CPU, a DSP, memory, etc., and is equipped with the calculation function which detects the relative distance between a phase contrast detection function and a base station 10 in addition to an original mobile station function. The slide correlator 25 consists of a back-diffusion-of-electrons coder 26 which is made to shift a diffusion sign and is made to generate a back-diffusion-of-electrons sign in order to take correlation with an input signal, and a back-diffusion-of-electrons circuit 27 which outputs the correlation value which multiplied the back-diffusion-of-electrons sign by the input signal.
[0079] Actuation of the gestalt of this operation constituted as mentioned above is explained referring to the timing chart of drawing 2 and drawing 3 .
[0080] Drawing 2 shows the condition that the base station 10 and the mobile station 20 are carrying out the spread-spectrum communication link mutually based on the criteria timing which each timers 12 and 22 give.
[0081] In a base station 10, if transmit data is inputted into the diffusion circuit 13 from the base station side control section 11, transmit data will be spread at the predetermined chip rate fc by the diffusion sign C1 in the transmit timing which a timer 12 gives in the diffusion circuit 13, and wireless transmission will be carried out from an antenna 14.
[0082] At this time, the spread spectrum of the diffusion sign C1 is multiplied and carried out to transmit data in the diffusion circuit 13 with the clock fc of the chip rate which a timer 12 generates. The criteria timing of a timer 12 gives the timing which the head of the diffusion sign C1 for carrying out the spread spectrum of the transmit data generates. When the counted value of the clock fc of a timer 12 is 0, specifically, the diffusion sign C1 is generated so that the head of the diffusion sign C1 may be multiplied by transmit data. Moreover, when counted value is maximum, the last of the diffusion sign C1 is multiplied by transmit data, counted value is reset with the following clock, counted value is again set to 0, and he is trying for the head of the diffusion sign C1 to appear.
[0083] Thus, wireless transmission of the signal (spread-spectrum signal) in which the timer 12 built in the base station 10 has the periodicity generated based on the criteria timing given periodically is carried out to a mobile station 20. The signal by which wireless transmission was carried out from the base station 10 reaches at a mobile station 20 after the propagation time Td proportional to the distance between a mobile station 20 and a base station 10.
[0084] On the other hand, in a mobile station 20, the spread spectrum of the transmit data given to the diffusion circuit 23 from the mobile station side control section 21 like a base station 10 is carried out with the diffusion sign C2 based on the criteria timing which the timer 22 of a local station gives, and wireless transmission is carried out from an antenna 24.
[0085] Thus, wireless transmission of the signal (spread-spectrum signal) with the periodicity generated based on the criteria timing which the built-in timer 22 gives periodically to a mobile station 20 to a base station 10 also from the mobile station 20 is carried out to a base station 10. Since it will serve as the same propagation path if the transmission to a mobile station 20

from the above-mentioned base station 10 and the time progress of the time amount to which the signal by which wireless transmission was carried out from the mobile station 20 arrives at a base station 10 are small, it turns into the same propagation time Td.

[0086] In a mobile station 20, while the input signal received with the antenna 24 is inputted into the back-diffusion-of-electrons circuit 27, back-diffusion-of-electrons sign C1' which the back-diffusion-of-electrons coder 26 generated is inputted into the back-diffusion-of-electrons circuit 27. Back-diffusion-of-electrons sign C1' carries out the sequential shift of the same diffusion sign C1 as the diffusion sign used for the spread spectrum in the back-diffusion-of-electrons coder 26 by the transmitting side, and is generated. That is, as shown in drawing 2 , the counted value of the timer 22 of a local station doubles the head of the diffusion sign C1 with the timing (criteria timing) of 0, and a sequential shift is carried out with a sampling period Ts until counted value turns into maximum and is reset.

[0087] At this time, the correlation output CR of the data stream of an input signal and back-diffusion-of-electrons sign C1' is outputted to the mobile station side control section 21 from the back-diffusion-of-electrons circuit 27. The mobile station side control section 21 detects the time amount from which the biggest correlation output CR was obtained. This correlation processing is called diffusion pattern matching of the back diffusion of electrons.

[0088] Time amount until the maximum of the correlation output CR is obtained by diffusion pattern matching of the back diffusion of electrons in a mobile station 20 consists of timer gap time amount with the criteria timing of the timer 22 of the mobile station 20 used as the criteria timing of the timer 12 of the base station 10 used as a transmitting side, and a receiving side, and the above-mentioned propagation delay Td. Time amount until the maximum of the correlation output CR is obtained on the basis of the criteria timing which the timer 22 of a mobile station 20 gives is made into the phase contrast T2 as local station detection phase contrast.

[0089] Phase contrast T2 is searched for [count / until it detects the maximum correlation output for a sampling rate fs for N times (integer of N>=1) of the chip rate fc / of a shift / n] from a degree type.

[0090] Phase contrast T2=nxTs — (1)

Moreover, the time amount = phase contrast T1 until the maximum of the correlation output CR is obtained on the basis of the criteria timing which the timer 12 of a base station 10 gives is detectable by performing diffusion pattern matching of the back diffusion of electrons based on the criteria timing which the timer 12 of a base station 10 gives the signal received from the mobile station 20 also in the base station 10. Phase contrast T1 turns into distant-office detection phase contrast.

[0091] The timer gaps T01 and T02 which are the time difference of phase contrast T1 and T2, a propagation delay Td, and criteria timing detected by drawing 3 with a base station 10 and a mobile station 20 are shown. As shown in this drawing, when the synchronization between the Communication Bureau (a base station, mobile station) cannot be taken, phase contrast Tn is expressed with a degree type, using a timer gap of the transmitting side on the basis of a receiving side as T0n.

[0092]

The transmitting-side synchronous gap T0n+ propagation time Td seen from the phase contrast Tn= receiving side — (2)

When phase contrast when making phase contrast T2 and a mobile station 20 into a transmitting side, and making a base station 10 into a receiving side for the phase contrast when making T01 base station 10 into a transmitting side, and making a mobile station 20 into a receiving side for a gap of the timer 22 of the mobile station [gap / the timer 12 of the base station 10 on the basis of a mobile station 20] 20 on the basis of T02 base station 10 is made into phase contrast T1, there is relation of a bottom type.

[0093]

T02+ propagation-time Td= phase contrast T2 — (3)

T01+ propagation-time Td= phase contrast T1 — (4)

While 22 is advancing on the basis of the base station 10 only as for the timerT01 of a mobile

station 20, when based reverse on a mobile station 20, only base station 10 timerT02 will be behind in 12.

[0094] Therefore, if there is relation of T01=-T02 and a formula (3) and a formula (4) are added, a timer gap of left part denies and there is, and only the propagation time Td can remain in left part, and can compute the distance L between a base station 10 and a mobile station 20.

[0095]

Propagation-time Td= (phase contrast T1+ phase contrast T2)/2 — (5)

Distance L= velocity-of-light x (phase contrast T1+ phase contrast T2)/2 — (6)

Moreover, if a formula (3) and a formula (4) are subtracted, the propagation time Td of left part denies and there is, and only a timer gap can remain in left part and can compute a gap of a synchronization.

[0096]

T01= (phase contrast T1-phase contrast T2)/2 — (7)

T02= (phase contrast T2-phase contrast T1)/2 — (8)

If it amends by the gap of the computed timer, distance L can also be found by the bottom formula.

[0097]

Distance L= velocity-of-light x (phase contrast T1-timer gap T01) — (9)

Distance L= velocity-of-light x (phase contrast T2-timer gap T02) — (10)

With the gestalt of this operation, when a mobile station 20 measures the distance to a base station 10, it transmits to a mobile station 20 from a base station 10 by using as transmit data phase contrast T01 detected based on the criteria timing of its own timer 12 in the base station 10 which received the signal from a mobile station 20.

[0098] In a mobile station 20, the phase contrast T01 which restored to the received data about the phase contrast T01 received from the base station 10, and was detected in the base station 10 is acquired. On the other hand, diffusion pattern matching of the back diffusion of electrons with the received data about the phase contrast T01 concerned detects the phase contrast T2 based on the criteria timing of the timer 22 of a local station.

[0099] In the mobile station side control section 21, the distance L from a mobile station 20 to a base station 10 is calculated based on the above-mentioned formula (6). Or you may make it calculate a relative distance L by the above-mentioned formula (7) and the above-mentioned formula (8) detecting the timer gap T02 of the base station 10 on the basis of a mobile station 20, or the timer gap T01 of the mobile station 20 on the basis of a base station 10, and amending a part for a timer gap based on a formula (9) or a formula (10).

[0100] Moreover, the timers 22 and 12 of a mobile station 20 and a base station 10 are set using the timer gaps T01 or T02 calculated by the formula (7) or the formula (8). For example, in a base station 10, the base station side control section 11 sets a timer 12 only for the timer gap T02 when being based on the timer 22 of a mobile station 20. In a mobile station 20, it is the same, and a lump activity may be done.

[0101] After losing a timer gap, you may make it calculate a relative distance L in a degree type.

[0102] Distance L= velocity-of-light x phase contrast — (11)

Next, the range error calculated based on phase contrast is explained.

[0103] Drawing 4 is the graph which indicated the relation of the correlation output P when carrying out the back diffusion of electrons to be said phase contrast T and shift-hours t of the diffusion code C by slide correlator (15 25) by the back-diffusion-of-electrons sign C'. In this drawing, shift-hours [of the diffusion code C according / an axis of abscissa / to slide correlator] t and an axis of ordinate are the correlation outputs P. In order to simplify explanation, the sample rate fs (period Ts) and the chip rate fc (period Tc) of drawing are considered as the relation of fs/fc=1.

[0104] As a description of the diffusion sign used for a spread-spectrum communication link, the maximum correlation output Pmax is obtained for shift-hours t at the time of 0, and difference deltat of the phase contrast T of a diffusion sign decreases in proportion to the absolute value of deltat, and if the absolute value of deltat becomes more than Tc, it will almost be set to 0. If it is made a formula, it will become a formula (12) and a formula (13).

[0105]
At the time of T-Tc<=t<=T P=(Pmax/Tc)x(t-T)+Pmax -- (12)
At the time of T<=t<=T+Tc P=-(Pmax/Tc)x(t-T)+Pmax -- (13)
Phase contrast T is detectable in approximation with the shift hours Tn in case a correlation output is max.
[0106] When the shift hours Tn in case a correlation output is max, and a difference with phase contrast T become max, it is a time of phase contrast T existing in the core of the sample period Ts. Since a range error delta x applies a time error and the velocity of light, if deltax<=cxTs/2 velocity-of-light c=3.0x108[m] sample rate fs=15MHz=1.5x107[/ second], it will become deltax <=10[m].
[0107] Furthermore, in order to raise phase contrast detection precision, deed phase contrast can be searched for for an approximation calculation to the correlation function of a formula (12) and (13) using the value of the sample beyond a value with a fixed correlation output. In the example of drawing 4 , the sampled value of (tm, Pm), and (Tn, Pn) is used. If (tm, Pm) are substituted for a formula (12) and (Tn, Pn) are substituted for a formula (13), since the number of linear expressions is two, phase contrast T can be searched for from binary [of Unknowns T and Pmax].
[0108] In the example of drawing 4 , since it is Tn=Tm+Ts=Tm+Tc, count becomes easy and phase contrast T can be found by count of a formula (14).
[0109]
T=Tn- {P1Tc/(P1+P2)} -- Supposing the error of a sampling period Ts can disregard the error of (14) correlation output P to the error of a correlation output 10%, the error of T becomes 10% of order of Ts, and at the time of fs=15MHz, the error of distance will become 1 [m] order and will become 10 [cm] order at the time of fs=150MHz. Although it was referred to as fs/fc=1 in order to simplify explanation, as for approximation, the way which took large fs/fc becomes accuracy more.
[0110] Since a distant office (base station 10) detects time difference (phase contrast T2) with criteria timing with the timer 22 of a local station (mobile station 20) from the signal which carried out spectrum diffusion and which has been transmitted with the timer 12 of a distant office and enabled it to detect distance from phase contrast T2 according to the gestalt of such operation, the base station 10 of the signal from the mobile office 20 is asynchronous, and can perform data communication. Moreover, since it is not premised on a distant office carrying out synchronous transmission, the dependability of distance detection precision improves.
[0111] In addition, although the gestalt 1 of the above-mentioned implementation explained the distance detection and timer gap detection between a base station 1 and a mobile station 20, it can apply also like distance detection of mobile stations and timer gap detection of an automobile etc., and can carry out. Between the vehicles of mobiles, such as an automobile, can be detected and the vehicles detection information can be used as control information of a mobile. Moreover, the vehicles detection information which the mobile detected can be sent to a traffic control system, and it can also use for generation of delay information etc.
[0112] (Gestalt 2 of operation) It has the function which chooses from a base station 10 the input signal of the electric wave which spread the minimum distance as the mobile station 20 explained with the gestalt 1 of the above-mentioned implementation.
[0113] As shown in drawing 5 , when a mobile station 20 exists under the site condition in which a building (obstruction) exists, a mobile station 20 also receives to coincidence the electric wave which reflected in the building other than the electric wave which spread the slant range between a base station 10 and a mobile station 20 (minimum distance), and was spread.
[0114] At this time, the electric wave which spread the slant range between a base station 10 and a mobile station 20 (minimum distance) reaches a mobile station 20 early most, as shown in drawing 6 , and attenuation of that electric wave is the smallest. Therefore, in the mobile station 20 used as a receiving station, the signal which has spread the minimum distance is most detected by the criteria timing of a timer 22 as most near and high pass of receiving level in two or more reception pass.
[0115] With the gestalt of this operation, it considers that the earliest reception pass of timing

spread the minimum distance between the Communication Bureau, and the reception pass by the reflected wave is removed from two or more detected reception pass. Or it considers that the high reception pass of receiving level spread the minimum distance between the Communication Bureau most, and the reception pass by the reflected wave is removed from two or more detected reception pass. Or most near and the high pass of receiving level are most chosen as the criteria timing of a timer in two or more reception pass.
[0116] According to the gestalt of such operation, since the reception pass by the reflected wave is efficiently removable, phase contrast detection can be performed based on the signal which spread the minimum distance, and timer gap detection can be performed.
[0117] (Gestalt 3 of operation) Other information is made to communicate among the Communication Bureau with the gestalt of this operation at the same time it performs ranging based on the distance detection method mentioned above among the Communication Bureau which carried the CDMA transmitter. The information exchanged to distance detection or timer gap detection, and coincidence among the Communication Bureau is arbitrary.
[0118] As shown in drawing 7 , Mobile A and Mobile C presuppose that the mobile B which does not belong to the same group is pinched among Mobiles A and C by the same group. Mobile C not only detects the phase contrast of the signal from Mobile A, but receives to coincidence the car information on the mobile [Mobile / A] A by which wireless transmission is carried out (for example, car number). And it judges whether the mobile B which runs the front belongs to a self-vehicle and the same group. Mobile C follows Mobile A based on the car information on Mobile A.

[0119] Since it is not necessary to return a response wave synchronizing with the input signal from a distant office in order to measure the distance between the Communication Bureau, according to the gestalt of such this operation, the information besides coincidence other than distance detection or timer gap detection can be transmitted and received.
[0120] (Gestalt 4 of operation) The gestalt of this operation is the example of the relative-speed-detector equipment which detects the relative velocity between cars for ranging based on the distance detection method mentioned above between the cars carrying a CDMA transmitter from the difference of a multiple-times deed and the relative distance at that time, and the time difference of the timing of ranging.
[0121] As shown in drawing 8 , while Cars A and B are moving on the same straight line, multiple-times activation of the distance detection is carried out by the same method as the mobile station of the gestalt 1 of operation mentioned above by Car A. By Car A, the relative velocity between the cars B in current is detected based on a bottom type.
[0122]
Relative-velocity V=(r2-r1)/(t2-t1) (15)
However, the relative distance by which r1 was detected by ranging in time of day t1, and r2 are the relative distances detected by ranging in time of day t2.
[0123] According to the gestalt of such this operation, relative velocity with a distant office is detectable using the detected relative distance.
[0124] (Gestalt 5 of operation) The gestalt of this operation is the example of the CDMA radio communication equipment which performs ranging of the distance detection method transmitted, received and mentioned above in the spread-spectrum communication mode, and determines transmitting power based on the relative-distance information at that time.
[0125] Therefore propagation distance becomes long, energy diffuses and decreases the electric wave which spreads space. The attenuation factor of a signal serves as a monotonically decreasing function of the relative distance between the Communication Bureau. The relative distance measured to the theoretical formula or empirical formula of said function is applied, an attenuation factor is searched for, and the receiving level of the Communication Bureau of a receiving side is controlled by adjusting the transmitted power of the Communication Bureau of a transmitting side.
[0126] According to the gestalt of such this operation, based on the distance information acquired by distance detection, transmitted power is controllable to a suitable value.
[0127] (Gestalt 6 of operation) The gestalt of this operation is an example using TDMA

communication system as a system which transmits and receives a signal with periodicity.

[0128] As shown in drawing 9 , a TDMA communication mode is communication system with which each Communication Bureau transmits to the predetermined timing assigned for every Communication Bureau the fixed period. The predetermined timing (slots A, B, and C) assigned by the TDMA method has given the allowances in consideration of the delay of the propagation time by the distance between the Communication Bureau, and each Communication Bureau transmits a signal to asynchronous in the range of these allowances.

[0129] The timing chart between the Communication Bureau A and B is shown in drawing 10 . The Communication Bureau A and B will do wireless transmission of the transmit data, if the criteria timing (slot A transmit timing, slot B transmit timing) given with the timer which each one has comes.

[0130] In the Communication Bureau A to which Slot A was assigned as transmit timing, the Communication Bureau B to which Slot B was assigned as transmit timing can expect the receiving timing (slot B reception anticipation timing) of transmit data which transmitted by Slot B based on its own timer. In the example of drawing 10 , the Communication Bureau A makes time amount TAB slot B reception anticipation timing. And slot B receiving timing tA' which actually received Slot B is detected.

[0131] With the gestalt of this operation, phase contrast tA is searched for in a degree type in the Communication Bureau A from time amount tA' until slot B receiving timing is detected from slot A transmit timing based on the timer of the Communication Bureau A, and the time amount TAB until it results [from slot A transmit timing] in slot B reception anticipation timing.

[0132]

Phase contrast tA= time amount tA'- Time amount TAB --- (16-1)

Here, the phase contrast tA calculated will have the same semantics as the phase contrast T1 and T2 of the gestalt of operation described above since it was the time amount which consists of a propagation delay between the Communication Bureau A and B, and a timer gap. Therefore, the same distance detection as a gestalt 1 and timer gap detection of operation are attained by searching for phase contrast tB from a degree type similarly in the Communication Bureau B.

[0133]

Phase contrast tB= time amount tB'+ time amount TAB --- (16-2)

(Gestalt 7 of operation) The gestalt of this operation is the example of the location specification equipment which pinpoints a location absolutely of the Communication Bureau where a location is unspecified using the above-mentioned distance detection method. Any of CDMA or a TDMA method are sufficient as a communication mode.

[0134] It explains with reference to drawing 11 . It radiocommunicates between two or more base stations B1 where it moved and the mobile station A and location where a location is unspecified have become clear by immobilization with time amount, B-2, and B3. In order to simplify explanation, a mobile station A, a base station B1, B-2, and B3 presuppose that it exists on the surface of the earth it can be considered substantially that is a flat surface. Moreover, the position coordinate of (X2, Y2), and a base station B3 is set [the position coordinate of a mobile station A / the position coordinate of (x, y) and a base station B1] to (X3, Y3) for the position coordinate of (X1, Y1), and base station B-2.

[0135] A mobile station A detects relative distances R1, R2, and R3 by the distance detection method shown in the gestalt of said operation by three base stations B1, B-2, and the radio of B3. The relation of a formula (17), a formula (18), and a formula (19) between position coordinates is with the above-mentioned relative distances R1, R2, and R3.

[0136]

(x-X1) 2+(y-Y1)2=R12 --- (17)
(x-X2) 2+(y-Y2)2=R22 --- (18)
(x-X3) 2+(y-Y3)2=R32 --- (19)

From three secondary types, since an unknown is binary [of x and y], it can ask for x and y from a formula (17), a formula (18), and a formula (19).

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The block diagram of the base station concerning the gestalt 1 of operation of this invention, and a mobile station
[Drawing 2] The timing-chart Fig. of the spectrum communication link between the base station in the gestalt 1 of operation, and a mobile station
[Drawing 3] The timing-chart Fig. for explaining the phase contrast detected with the base station in the gestalt 1 of operation, and a mobile station
[Drawing 4] Drawing showing the correlation output for explaining the approximation calculation of the phase contrast in the gestalt 1 of operation
[Drawing 5] Drawing showing the received wave propagation path between the Communication Bureau in the gestalt 2 of operation of this invention.
[Drawing 6] The wave form chart showing the receiving level in the receiving station in the gestalt 2 of operation
[Drawing 7] Drawing showing the physical relationship between the cars in the gestalt 3 of operation of this invention
[Drawing 8] The conceptual diagram for explaining the relative-speed-detector principle between the Communication Bureau in the gestalt 4 of operation of this invention
[Drawing 9] Drawing showing the transmission period of the TDMA method in the gestalt 6 of operation of this invention
[Drawing 10] The principle explanatory view of the phase contrast detection in the gestalt 6 of operation
[Drawing 11] Drawing showing the physical relationship of the mobile station and base station in the gestalt 7 of operation of this invention
[Description of Notations]
10 Base Station
11 Base Station Side Control Section
12 22 Timer
13 23 Diffusion circuit
14 24 Antenna
15 25 Slide correlator

[Translation done.]

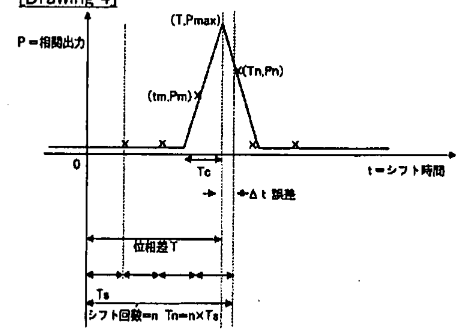
* NOTICES *

JPO and NCIPI are not responsible for any
damages caused by the use of this translation.

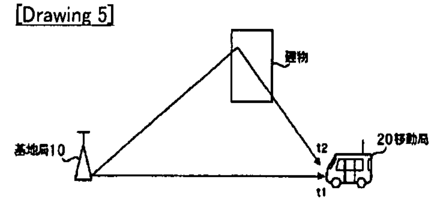
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

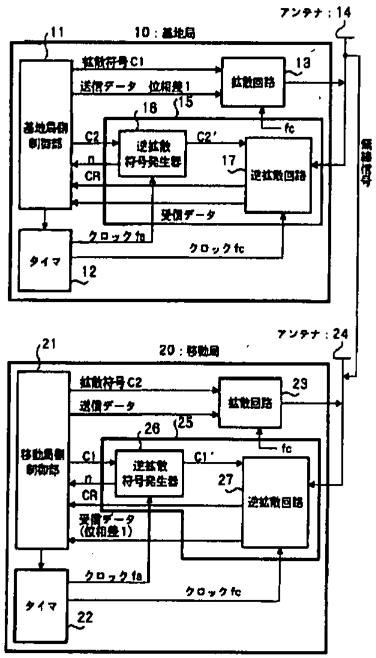
[Drawing 4]



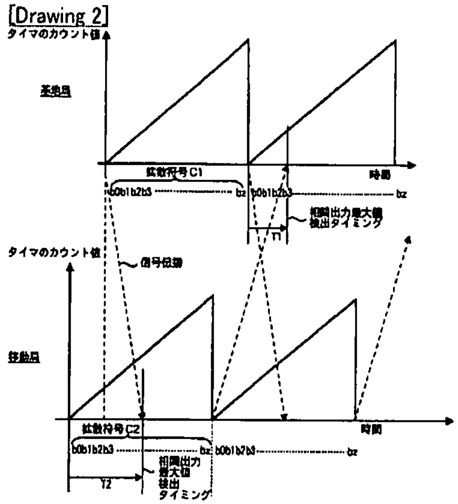
[Drawing 5]



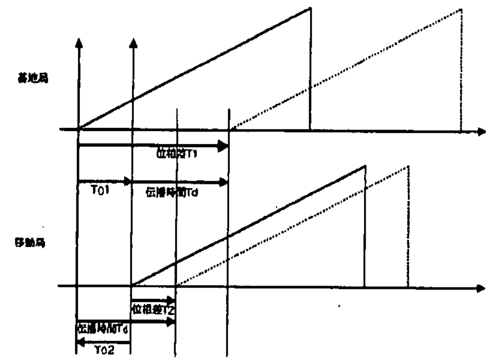
[Drawing 1]



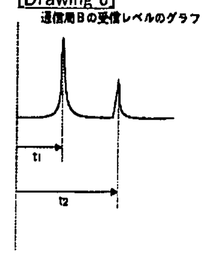
[Drawing 2]



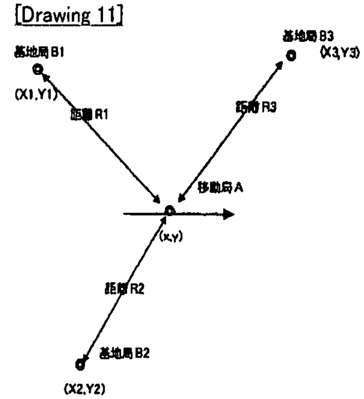
[Drawing 3]



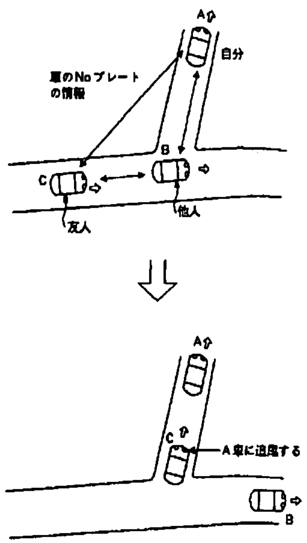
[Drawing 6]



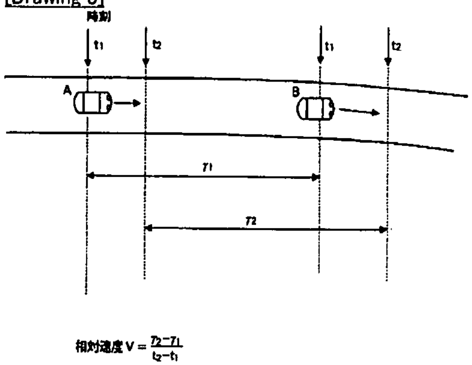
[Drawing 11]



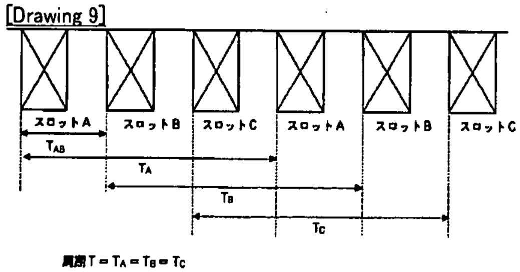
[Drawing 7]



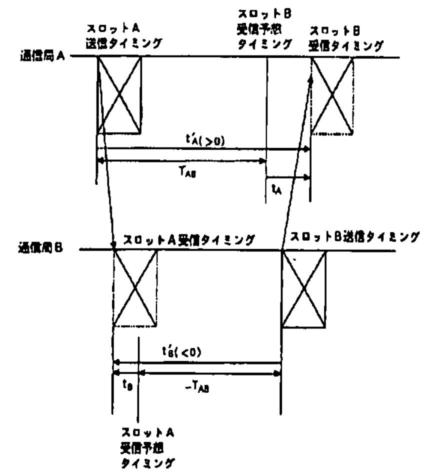
[Drawing 8]



[Drawing 9]



[Drawing 10]



[Translation done.]